Easy Automotive Modules

Application Note

Evaluation Kit **EASYKIT AUX DRIVES**
(FS50R07W1E3_B11A)

AN2012-10

Revision 1.1

Electric Drive Train

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04-2013	1.1	T. Reiter T. Hoffmann	Added picture for CAN control more jumper position. Added information about terminal program with uConnect

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Table of Contents **Page**

1 Introduction 6
1.1 Safety Warning for Evaluation KIT 6
1.2 How to Order the Evaluation Kit 6

2 Quick Start Guide 7
2.1 Mount System on a Cooling Plate 7
2.2 Connect Supplies and Load 9
2.3 Operation of Power Board only 10
2.3.1 Power Board Connector Description 11
2.4 Recommended Test Setup and Equipment 12

3 Feature Description 13
3.1 Key Features 13
3.2 Protection Features 14
3.3 Key Components BOM 14

4 Operating Modes and LED status 15
4.1 Mode 1 (Default): Self test, soft start, and motor rotation 15
4.2 Mode 2 (Jumper): CAN controlled mode for output frequency and voltage 15
4.3 Mode 3 (Jumper): CAN controlled low side single pulse test 16
4.4 Status LEDs 16
4.5 Self Test Sequence 18
4.6 Motor Control (U/f) Concept 25

5 Evaluation Kit CAN Terminal 26
5.1 Introduction and Feature Description 26
5.2 CAN Terminal Quick Start Guide 27
5.3 How to install SW on UConnect stick 28
5.4 Using the CAN Terminal Feature 28

6 Experimental Results 31
6.1 Test sequence 31
6.2 Short Circuit Tests 32
6.2.1 Short Circuit I (low inductance) 32
6.2.2 Short Circuit II (high inductance) 33
6.3 IGBT Turn-off (300V, 25A, 150°C) 35
6.3.1 IGBT Turn-on (300V, 25A, 150°C) 37
6.3.2 Diode Turn-off (300V, 25A, 150°C) 39
6.3.3 IGBT Turn-off (450V, 100A, 25°C) 40
6.4 Motor run (Default Mode 1) 41

7 Schematics Power Board 43
7.1 Overview Inverter System 43
7.2 Overview Power Board 44
7.3 Connector on Power Board 45
7.4 Gate Driver 46
7.5 Easy Module 47
7.6 Amplifier Stage 48
7.7 Comparator Stage 49
7.8 Layout and Assembly Power Board 50

8 Schematics Control Board 51
8.1 Overview Control Board 51
8.2 Connector from Power Board 52
8.3 LV Supply 53
8.4 Isolated Supplies 54
8.5 uC 55
8.6 CAN Communication and FAN 56
8.7 Diagnosis and DAP Connector 57
8.8 Layout and Assembly of Control Board 58

Table of Contents **Page**

9 CAN Messages 59

10 References 63

1 Introduction

The Evaluation Kit "*EASYKIT AUX DRIVES"* was developed to support customers during their first steps in designing applications with the Easy 1B Automotive B6-Bridge power module. These modules are targeted for high voltage pumps and compressor applications within hybrid- and electric vehicles.

The application note explains how to start with the Evaluation Kit and explains the design. The information is intended to enable the customers to re-use and modify the Evaluation Kit design for their own specific requirements.

1.1 Safety Warning for Evaluation KIT

Please read and understand the manual and the following safety warnings.

The design operates with unprotected high voltages. Therefore, the Evaluation Kit may only be handled by persons with sufficient electrical engineering training and experience. The customer assumes all responsibility and liability for its correct handling and/or use of the Evaluation Kit and undertakes to indemnify and hold Infineon Technologies harmless from any third party claim in connection with or arising out of the use and/or handling of the Evaluation Kit by the customer.

The Evaluation Kit is a sample to be used by the customer solely for the purpose of evaluation and testing. It is not a commercialized product and shall not be used for series production.. The Evaluation Kit is thus not intended to meet any automotive qualifications. Due to the purpose of the system, it is not subjected to the same procedures regarding Returned Material Analysis (RMA), Process Change Notification (PCN) and Product Withdraw (PWD) as regular products. See Legal Disclaimer and Warnings for further restrictions on Infineon Technologies warranty and liability.

European legislation in relation to inter alia the restriction of hazardous substances (RoHS), waste from electrical and electronic equipment (WEEE), electromagnetic compatibility, as well as duties to comply with CE, FCC or UL standards do not apply to the Evaluation Kit and the Evaluation Kit may not fulfill such requirements..

1.2 How to Order the Evaluation Kit

The Evaluation Kit has Infineon Technologies SAP number and can be ordered via Infineon Sales Partners.
EASYKIT AUX DRIVES SAP Order Number: **SP001020068**

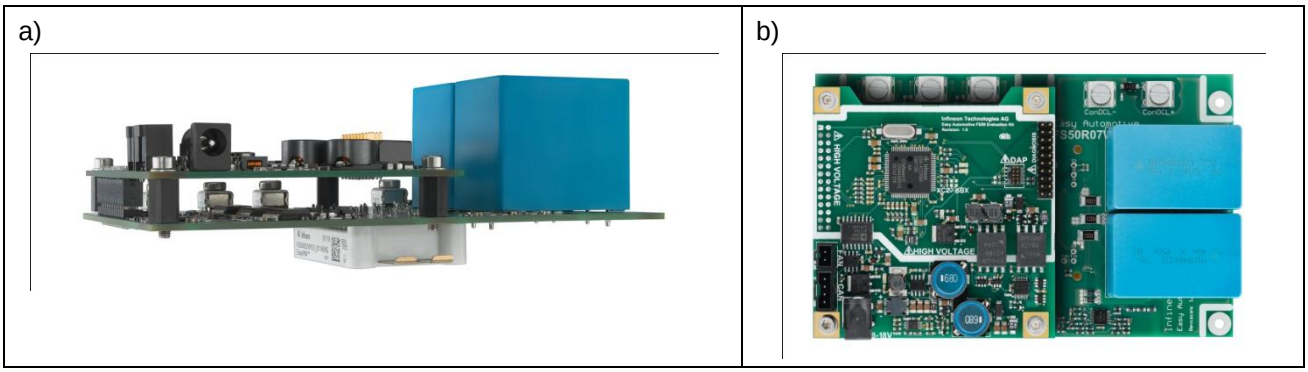


Figure 1 Pictures of the "EASYKIT AUX DRIVES" Evaluation Kit (typical appearance).

2 Quick Start Guide

Before operating this Evaluation Kit two steps are necessary:

1. Mount system on a cooling plate
2. Connect aux supply, HV supply and a 3phase AC motor (or alternative load)
3. Motor starts running automatically per default (see chapter 4 for CAN control modes)

Please read the entire application note carefully in order to prevent accidents and damage on the Evaluation Kit.

2.1 Mount System on a Cooling Plate

The power module can be attached directly on a cooling plate after applying a thermal grease of 50 um thickness (e.g. Fischer WLP). Detailed information on the mounting of the Easy Automotive Module can be found in [2].

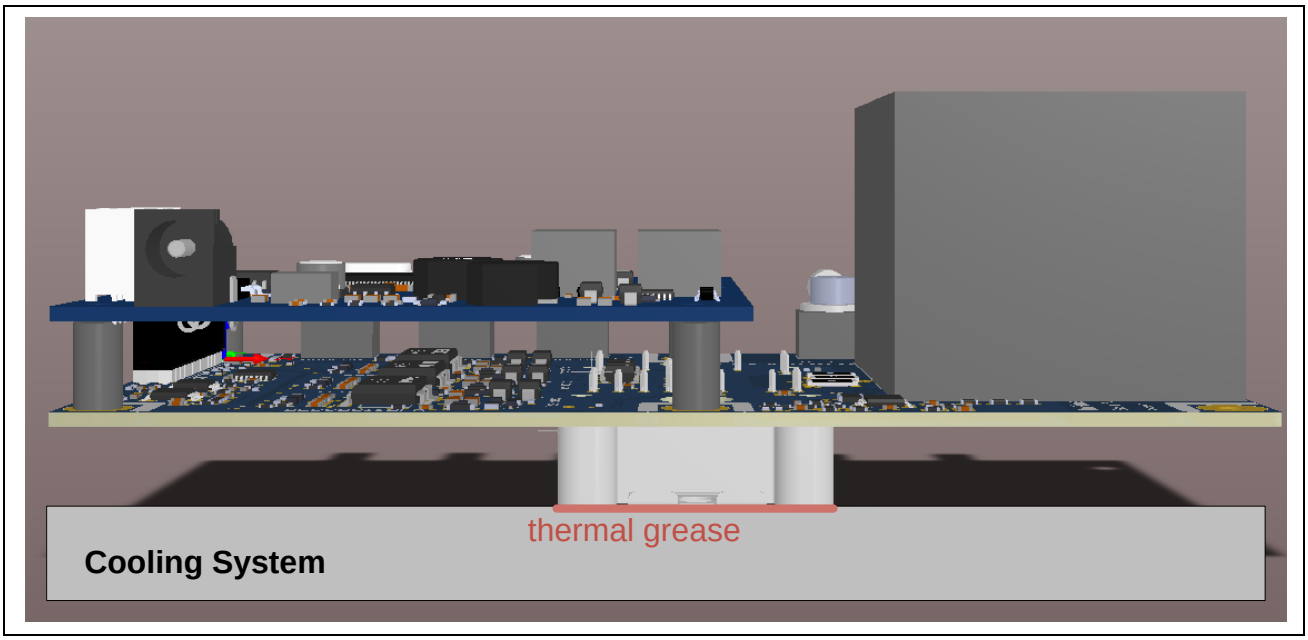


Figure 2 Mounting for quick start with the Evaluation Kit. Standard thermal grease is applied between module and cooler. The module is fixed with screws via the module integrated clamps. See Application Note [2] for recommended mounting instructions.

The cooler design depends on the specific requirements of the target system. The highest performance and power density can be achieved with water cooling systems. Nevertheless, forced air cooling is typically easier for first tests in the high voltage lab. An example of a forced air cooler was designed, where the DCL-capacitor was placed on the bottom of the PCB to achieve a compact system design (see Figure 3). The drawings for the sample air cooler can be taken from Figure 4.

Measurements with the cooler prototype Assmann WSW: ASS_1060_HSrev01 and FAN: AFB0612VHC running at 15 V showed an Rth (heatsink to ambient) of approximately 0.4 K/W.

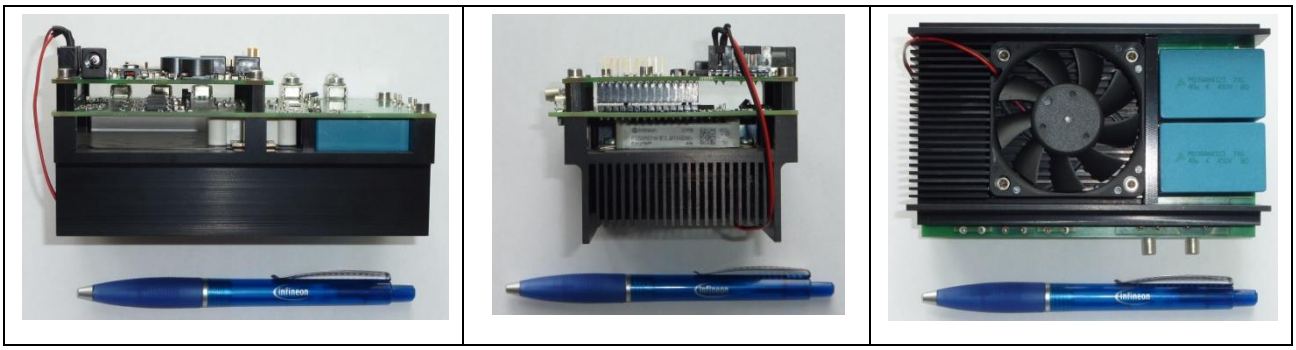


Figure 3 EASY AUX DRIVES Evaluation Kit mounted on a sample forced air cooler from Assmann WSW.

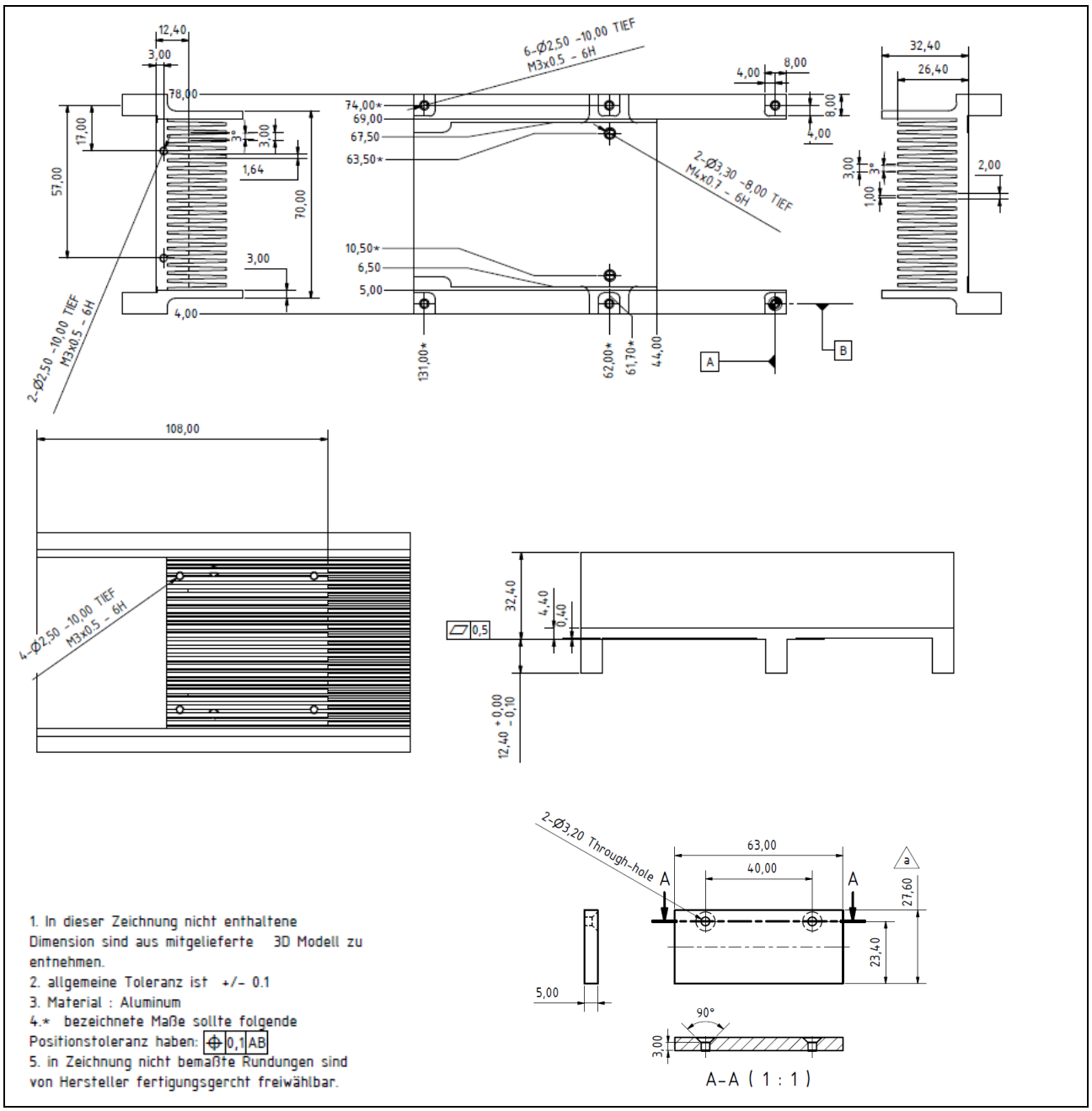


Figure 4 Drawing of a sample forced air cooler (Assmann WSW: ASS_1060_HSrev01).

2.2 Connect Supplies and Load

The Evaluation KIT has to be connected to a 8..18V auxiliary supply, which can deliver at least 2A. On the HV power connectors a supply <450V and a 3ph induction machine (or equivalent load) has to be applied. The connections are illustrated in Figure 5.

Please take note that only the aux supply is reverse polarity protected up to -20V. The power terminals for the <450V DCL supply is not protected against reverse polarity events and will lead to failed diodes if current is not limited.

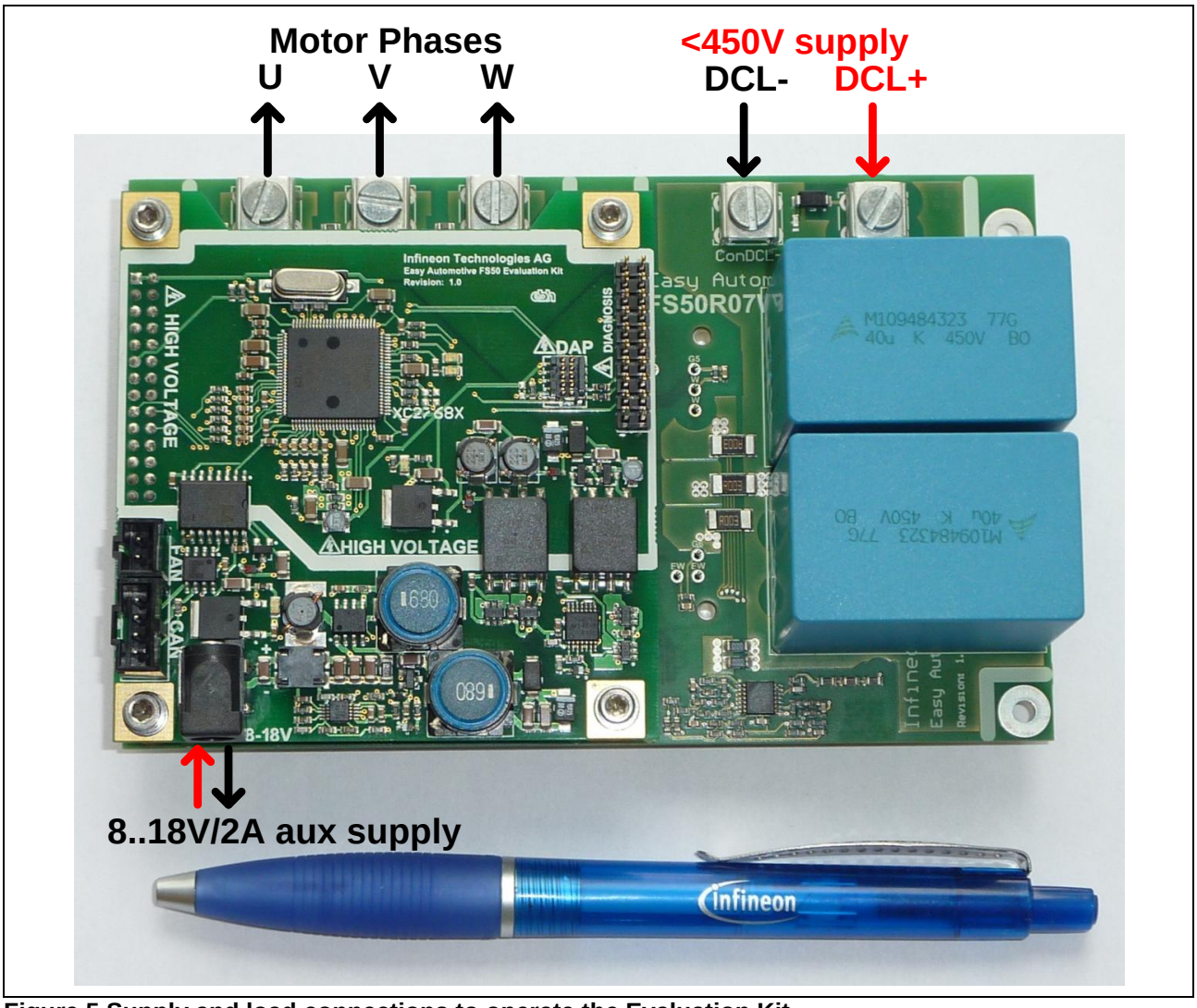


Figure 5 Supply and load connections to operate the Evaluation Kit.

2.3 Operation of Power Board only

Some investigations, like typical double pulse switching tests, are easier to perform without a control board and software. The pulse patterns are generated here from a function generator.

For such an operation, the power board needs some minor modifications. Three zero ohm bridges has to be placed. The location for these bridges are illustrated in Figure 6.

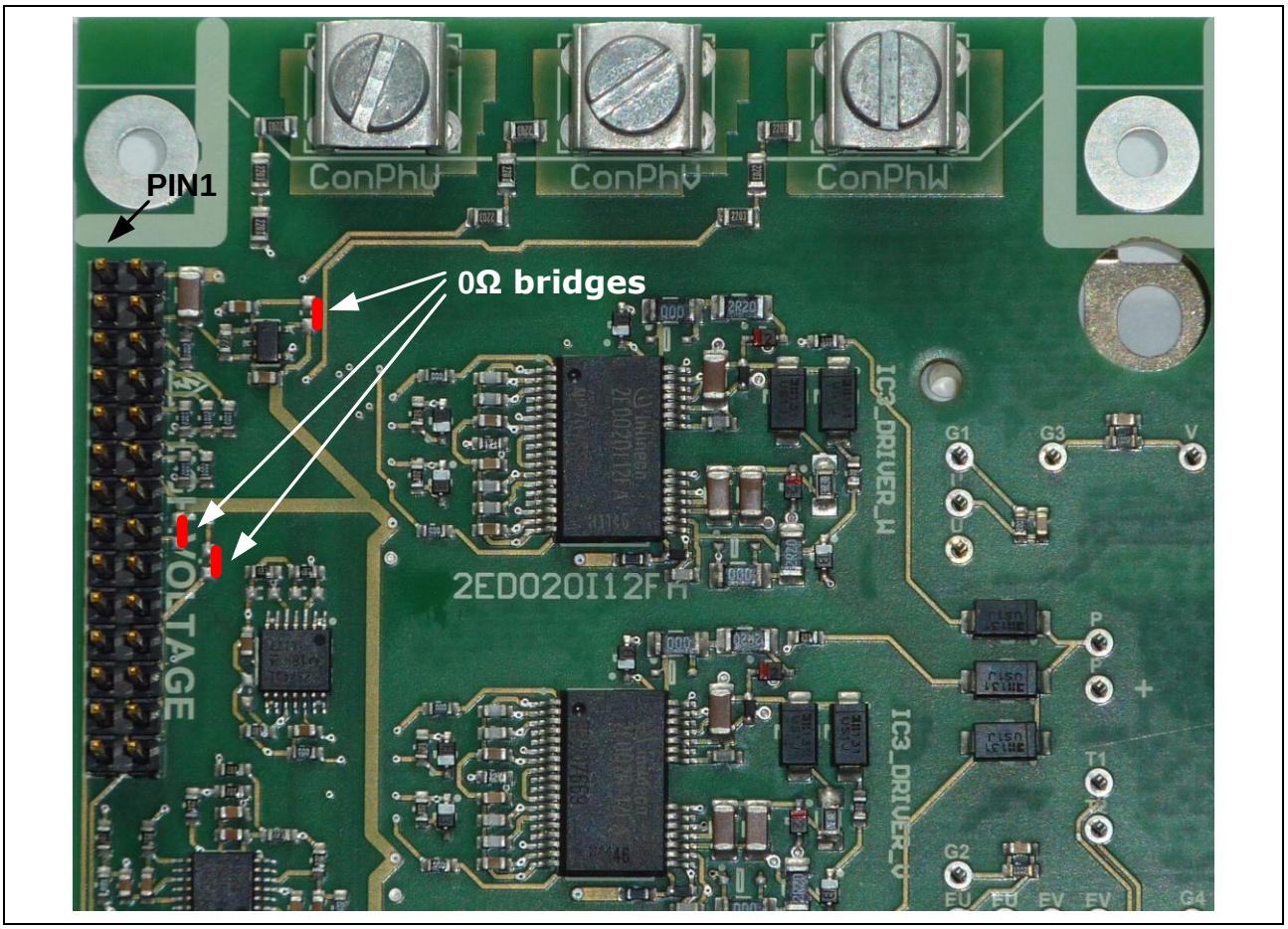


Figure 6 Three required 0Ω bridges if tests without control board has to be performed.

The required signals on the connectors for power board only operation is described in Section 2.3.1.

2.3.1 Power Board Connector Description

For Pin1 location please see Figure 6.

No.		Signal	Description
1		**+15V_HV**	**+15V gate driver supply (required for power board only operation)**
	15	+15V_HV	+15V gate driver supply
2		**GND_DIG**	**Digital Ground (required for power board only operation)**
	16	GND_DIG	Digital Ground
3		PWM_UB	PWM Input for Low-Side IGBT Phase U
	17	PWM_UT	PWM Input for High-Side IGBT Phase U
4		PWM_VB	PWM Input for Low-Side IGBT Phase V
	18	PWM_VT	PWM Input for High-Side IGBT Phase V
5		PWM_WB	PWM Input for Low-Side IGBT Phase W
	19	PWM_WT	PWM Input for High-Side IGBT Phase W
6		**+5V_HV**	**+5V logic supply**
	20	HSflt_disable	HighSide gate driver fault event hiding. Required to start bootstrap supply. Function is continuous on for power board only operation – no signal required.
7		**nRST_uC**	**Not RESET input from the uC. (connect to +5V_HV Pin 6 for power board only operation)**
	21	nFLT_uC	Not FAULT output signal to the uC
8		+5V_HV_ana	+5V analog supply. (is connected to +5V_HV – Pin6 for power board only operation – no supply required)
	22	+5V_HV_ana	+5V analog supply. (is connected to +5V_HV – Pin6 for power board only operation – no supply required)
9		AnalogV_PHU	Analog 0..5V output signal of phase U voltage
	23	Analog_NTC	Analog 0..5V output signal of NTC temperature
10		AnalogV_PHV	Analog 0..5V output signal of phase V voltage
	24	AnalogI_PHU	Analog 0..5V output signal of low side phase U current (ratiometric output)
11		AnalogV_PHW	Analog 0..5V output signal of phase W voltage
	25	AnalogI_PHV	Analog 0..5V output signal of low side phase V current (ratiometric output)
12		AnalogV_DCL	Analog 0..5V output signal of DCL-voltage
	26	AnalogI_PHW	Analog 0..5V output signal of low side phase W current (ratiometric output)
13		GND_ANA	Analog Ground (is connected to GND_DIG – Pin2 for power board only operation – no supply required)
	27	NC	Not connected
14		GND_ANA	Analog Ground (is connected to GND_DIG – Pin2 for power board only operation – no supply required)
	28	GND_ANA	Analog Ground (is connected to GND_DIG – Pin2 for power board only operation – no supply required)

Minimum required signals for power board only tests have indicated with bold font.

2.4 Recommended Test Setup and Equipment

Minimum to operate the Evaluation Kit:

- 8-18V/2A DC source
- 450V 20A DC source
- Cooler plate and thermal grease (see section 2.1)
- 3ph induction machine or equivalent inductive load

For diagnosis, control and SW updates additional:

- Infineon UConnect XC2xxxX for low cost CAN terminal functionality
- HighSpeed CAN toolset (1MBit/s)
- DAP miniWiggler (can be ordered in ISAR: SP001020068)
- Tasking VX toolset for C166

For investigations on the switching behavior additional:

- 4 channel scope (min. 100 MHz)
- Differential probes (capable for measuring 650V)
- Rogowski current probe (e.g. CWT1)

For investigations on the efficiency additional:

- 4 channel power analyzer (range 400V/50A)

3 Feature Description

3.1 Key Features

- **Inverter for 3ph induction machine (pumps and compressors)**
- Up to 450V DCL voltages
- Overcurrent and short circuit detection
- DCL overvoltage and under voltage lockout
- 3x low side current sensor
- 3x phase voltage and 1x DCL voltage sensor
- Controller PCB temperature sensor
- Module DCB temperature sensor (via NTC)
- HighSpeed CAN Communication (1MBit/s)
- Optional PWM controlled 15V FAN output (<400mA continuous)
- **3 Implemented Operating Modes:**
  Mode1 (Default): Self test, soft start, and motor rotation (fixed output frequency).
  Mode2 (Jumper): CAN controlled mode for output frequency and voltage.
  Mode 3 (Jumper): CAN controlled low side single pulse test (1us step width).
- **Low cost CAN terminal functionality**

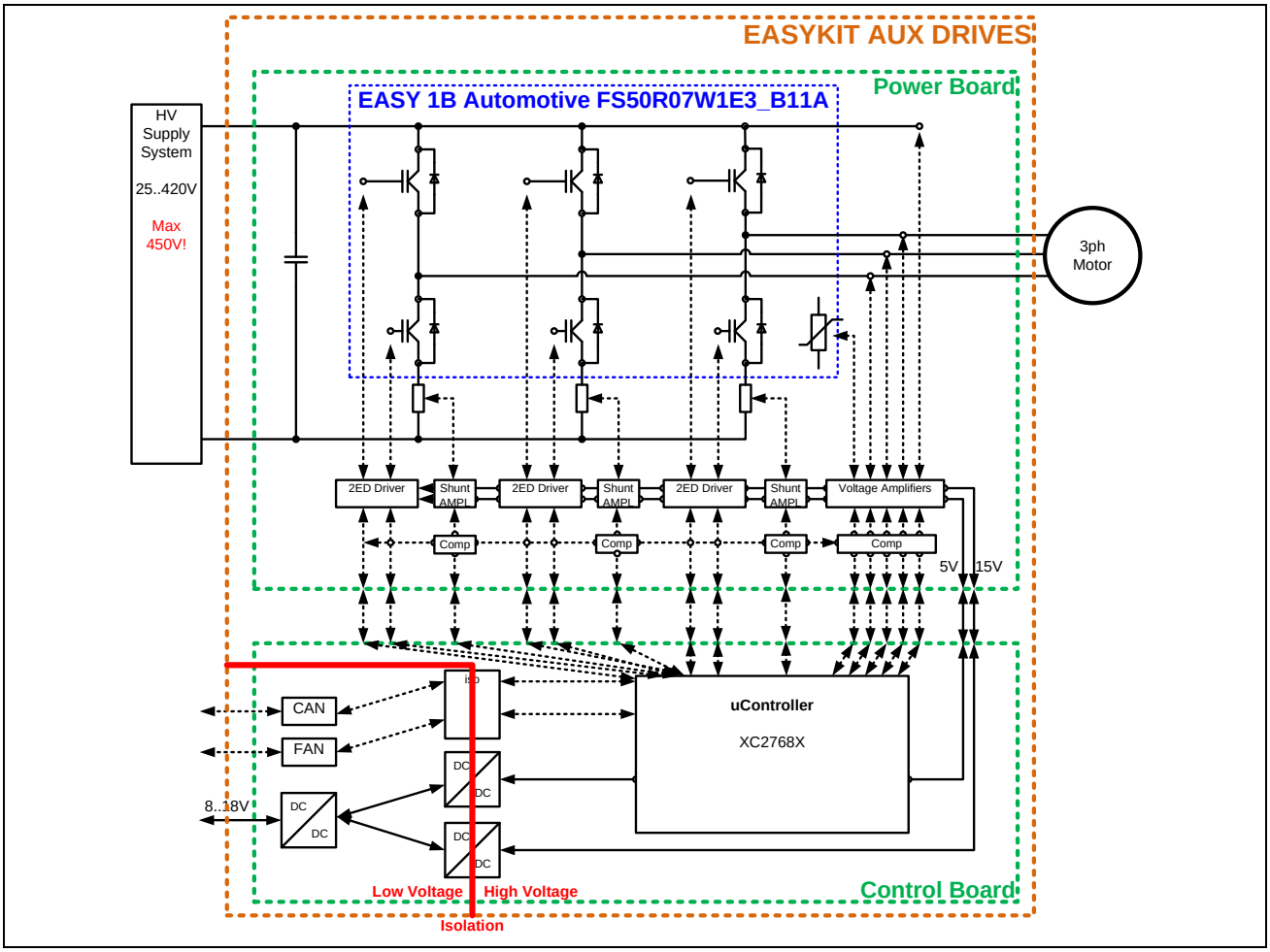


Figure 7 System architecture of the "EASYKIT AUX DRIVES" Evaluation Kit.

3.2 Protection Features

The protection features in this Evaluation KIT are limited. Please take note that testing beyond maximum rating may lead to device failures and damages. Infineon will not take any liability for failures on the Evaluation KIT as well as damage on lab equipments.

The design is not protected against:

- X Overtemperature
- X DCL Overvoltage (>450V)
- X Reverse polarity. (Only on 8-18V LV supply)
- X Overcurrent, Overvoltage on FAN output

Following protection features are implemented and activated:

- Overcurrent 8-18V supply with self restart (hiccup-mode)
- Reverse polarity protection 8-18V supply (up to -20V)
- Gate Driver Under voltage Lockout (UVLO)
- Gate Driver not Ready event locks all other Channels
- Shoot-through protection
- IGBT desaturation/short circuit (and overcurrent on low side IGBTs)
- DCL under- and overvoltage lockout (stop switching operation only)

3.3 Key Components BOM

Part	Description	Manufacturer	Status
FS50R07W1E3_B11A	Easy 1B Automotive B6-bridge with IGBT3 and Emitter Controlled Diode 3 650V/50A	Infineon	Productive
2ED020I12FA	EiceDriver™ 2A Dual Channel Gate Driver	Infineon	Productive
SAK-XC2768X	16/32-Bit Single-Chip Microcontroller	Infineon	Productive
TLE8250G	CAN Transceiver	Infineon	Productive
BSO604NS2	Dual 55V, 35mΩ OptiMOS™	Infineon	Productive
TLE7274-2D	5V LDO linear voltage regulator	Infineon	Productive
T7509	SMD Gate Driver Supply Transformers 1:1.1 5mm clearance/creepage	TDK/Epcos	*
B32776G4406+000	450V 40uF MKP foil DCL Capacitor	TDK/Epcos	*

* For status and datasheets of the passive TDK/Epcos components please ask design-solutions@epcos.com.

4 Operating Modes and LED status

4.1 Mode 1 (Default): Self test, soft start, and motor rotation

This mode is selected per default in the standard delivery condition. After the Evaluation Kit has an appropriated supply voltage, first a self test is performed and after PASS result the phase output is ramped in a soft start function to a fixed output frequency. The induction machine is running open loop. All of these items are performed automatically and it requires no user interaction, which makes first test “Easy”.

Safety Warning: Please note that the motor is starting to rotate automatically in this operating mode. Make sure that the motor is fixed properly and a motor rotation will not lead to dangerous situations for persons in the near environment.

4.2 Mode 2 (Jumper): CAN controlled mode for output frequency and voltage

If a Jumper is placed on the diagnosis header between pin 12 and 13, the Evaluation Kit runs in CAN Mode. The easiest way to use the CAN functionality is given with the CAN terminal function. Please see chapter 5 for more information of this low cost terminal solution.

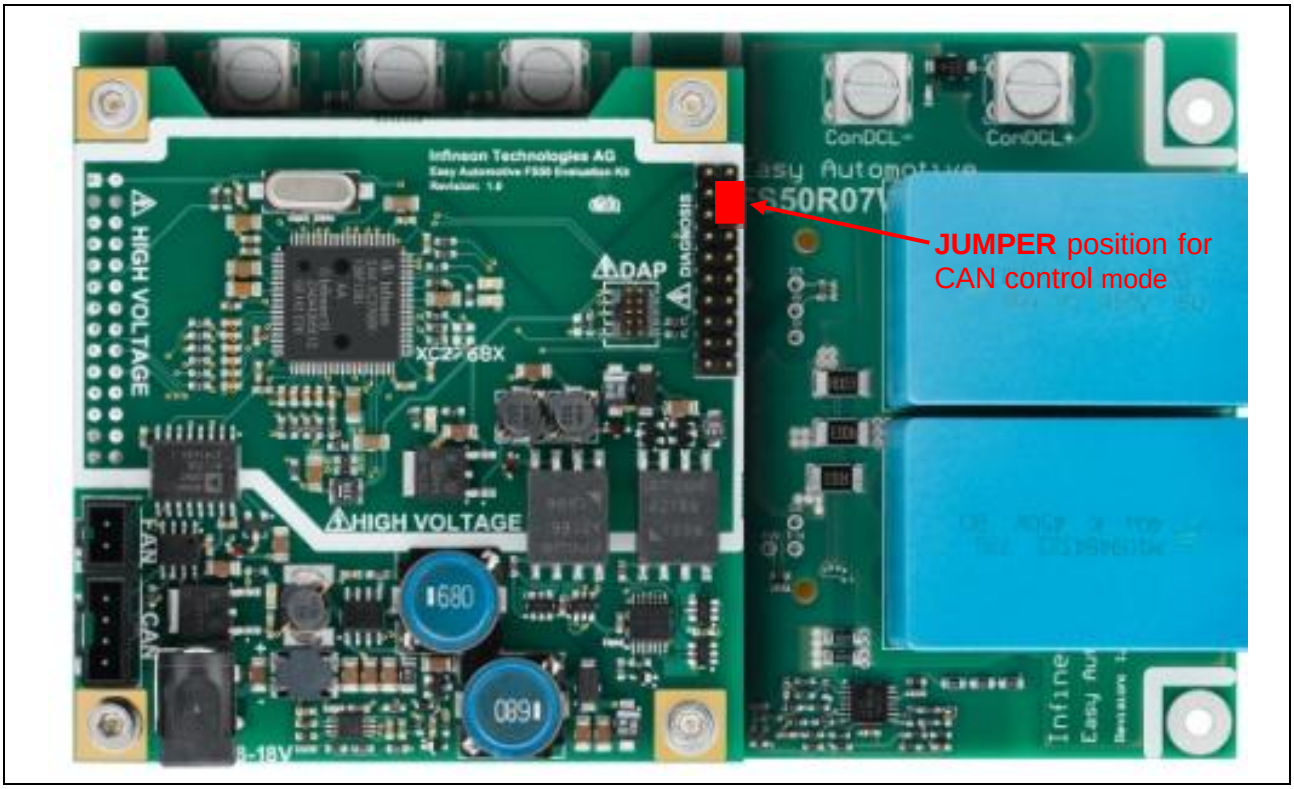


Figure 8 Required jumper position for enabling the CAN controlled mode.

After the self test routine is successfully passed it waits for CAN messages. In this mode the output frequency and voltage for the motor can be programmed to adjust the motor speed.

Following CAN Messages are minimum required to get the motor running:

- The nominal output voltage (line to line) has to be applied with CAN Message:
  CAN-ID *11hex*, Signal Name *PVacNom*, Data Type *Unsigned*, Bit Start 16, Bit Length *16*, Unit *V Q4 (16 ↔ 1 V)*

- The nominal output frequency has to be applied with CAN Message:
  CAN-ID 11hex, Signal Name *PFacNom*, Data Type *Unsigned*, Bit Start 0, Bit Length 16, Unit Hz *Q6* (64 ↔ 1 Hz)
- The target output frequency has to be applied with the CAN Message:
  CAN-ID 10hex, Signal Name *DFacSet*, Data Type Signed (negative value for change of rotation direction), Bit Start 16, Bit Length 16, Unit Hz Q6 (64 ↔ 1 Hz)
- The motor starts to run after CAN Message:
  CAN-ID 10hex, Signal Name DEnable, Data Type Bit, Bit Start 0, Bit Length 1
- The target frequency can now be continuously adjusted and will be slowly ramped to these new values.

4.3 Mode 3 (Jumper): CAN controlled low side single pulse test

The CAN controlled mode (required jumper position see Figure 8) allows single pulse switching tests on an arbitrary low side switch without the need of a function generator. The easiest way to use the CAN functionality is given with the CAN terminal function. Please see chapter 5 for more information of this low cost terminal solution. The single pulse test is a useful mode if you want to test turn-off overvoltages. For these tests a power inductor has to be connected between the phase output and DCL+ connection like in standard double pulse test benches (see Figure 22, Figure 24, Figure 26, Figure 28 for pulse test configurations).

- This mode can be entered if a Jumper is placed on the diagnosis header between pin 12 and 13 (similar to Mode 2).
- Following CAN Message is required to enter single pulse testing:
  CAN-ID *10hex*, Signal Name *DSglPulse*, Data Type *Bit*, Bit Start 2, Bit Length *1*
- The switch has to be selected with CAN Message (multiple or a single switch can be selected):
  CAN-ID *10hex*, Signal Name *DSglPulseULs*, Data Type *Bit*, Bit Start *3*, Bit Length *1*
  CAN-ID *10hex*, Signal Name *DSglPulseVLs*, Data Type *Bit*, Bit Start 4, Bit Length *1*
  CAN-ID *10hex*, Signal Name *DSglPulseWLs*, Data Type *Bit*, Bit Start 5, Bit Length *1*
- The pulse length has to be applied with CAN Message:
  CAN-ID *10hex*, Signal Name *DSglPulseLength*, Data Type *Unsigned*, Bit Start 16, Bit Length *16*, Unit *µs* Q0 *(1 ↔ 1 µs, pulse length is limited to a maximum of 500 µs)*
- Toggling following CAN Message from 0 to 1 applies the programmed pulses to the output
  CAN-ID *10hex*, Signal Name *DEnable*, Data Type *Bit*, Bit Start *0*, Bit Length *1*

4.4 Status LEDs

The status led’s indicates to the operator in a very fast way several failure and operating mode conditions of the Evaluation Kit.

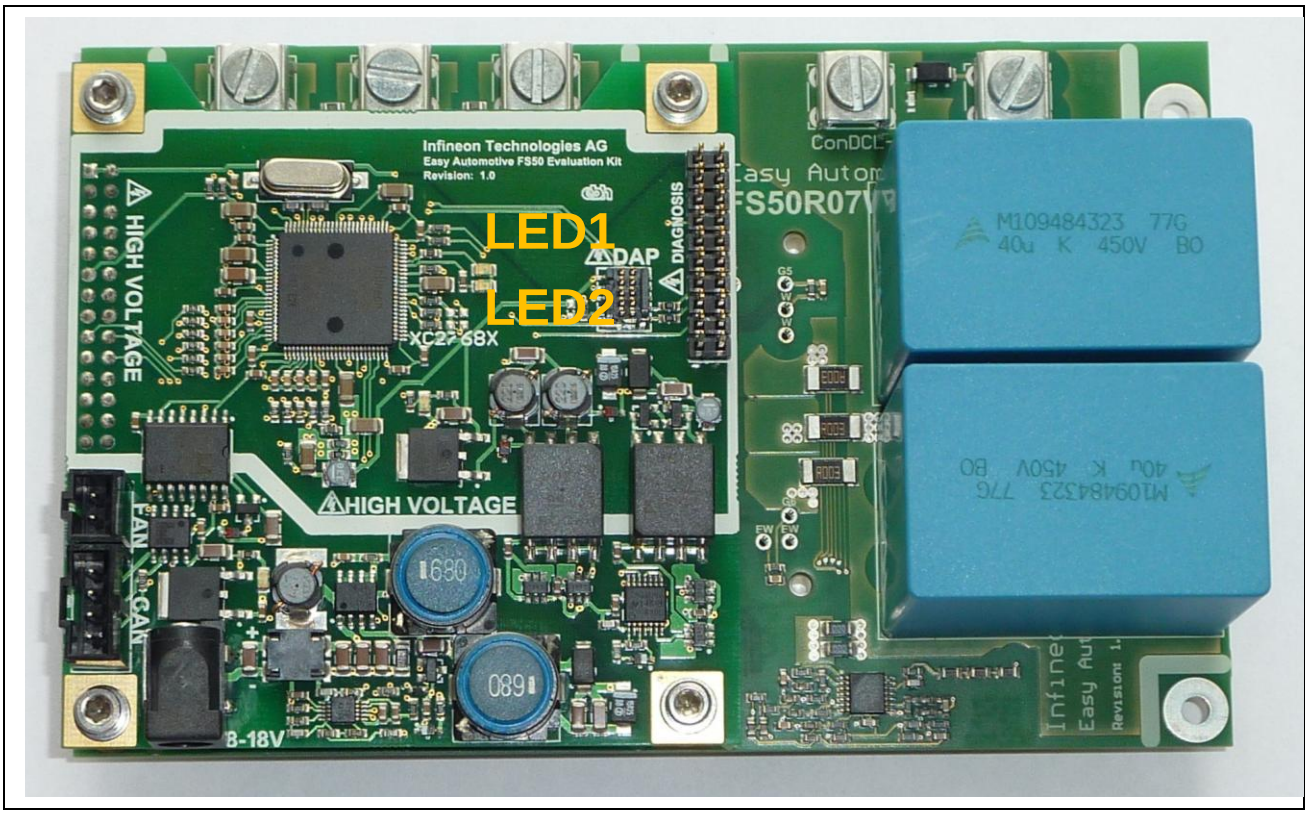


Figure 9 Location of status leds. Led 1 is closer to the top edge of the control PCB.

LED1	LED2	State
Flashing quickly	Flashing quickly complementary to LED1	**Self test, wait** due to low DCL voltage. Increase >25V for continue operation.
Flashing quickly	Off	**Self test, error** due to problems in passive sequence test part
Off	Flashing quickly	**Self test, error** due to problems in active sequence test part
On	Off	**Stop** (DCL voltage out of operating range OR internal failures)
On	Flashing slowly	**Ready** (waiting for enable in CAN mode)
On	Flashing quickly	**Run** (PWM output active)
Flashing slowly	Flashing slowly synchronize to LED1	**Error** (repetitive internal failures)
Flashing slowly	Flashing slowly complementary to LED1	**Single pulse mode (Mode 3)**

Flashing quickly: approx 10Hz; Flashing slowly: approx 2Hz

Internal failures: temperature failure, overcurrent, gate driver fault/not ready, HW trip from overcurrent, overvoltage, uC supply.

The state diagram of the implemented SW is shown in Figure 10. The operator has with the led's a simple and fast way to determine the current state without using CAN communication, where much more detailed information is given.

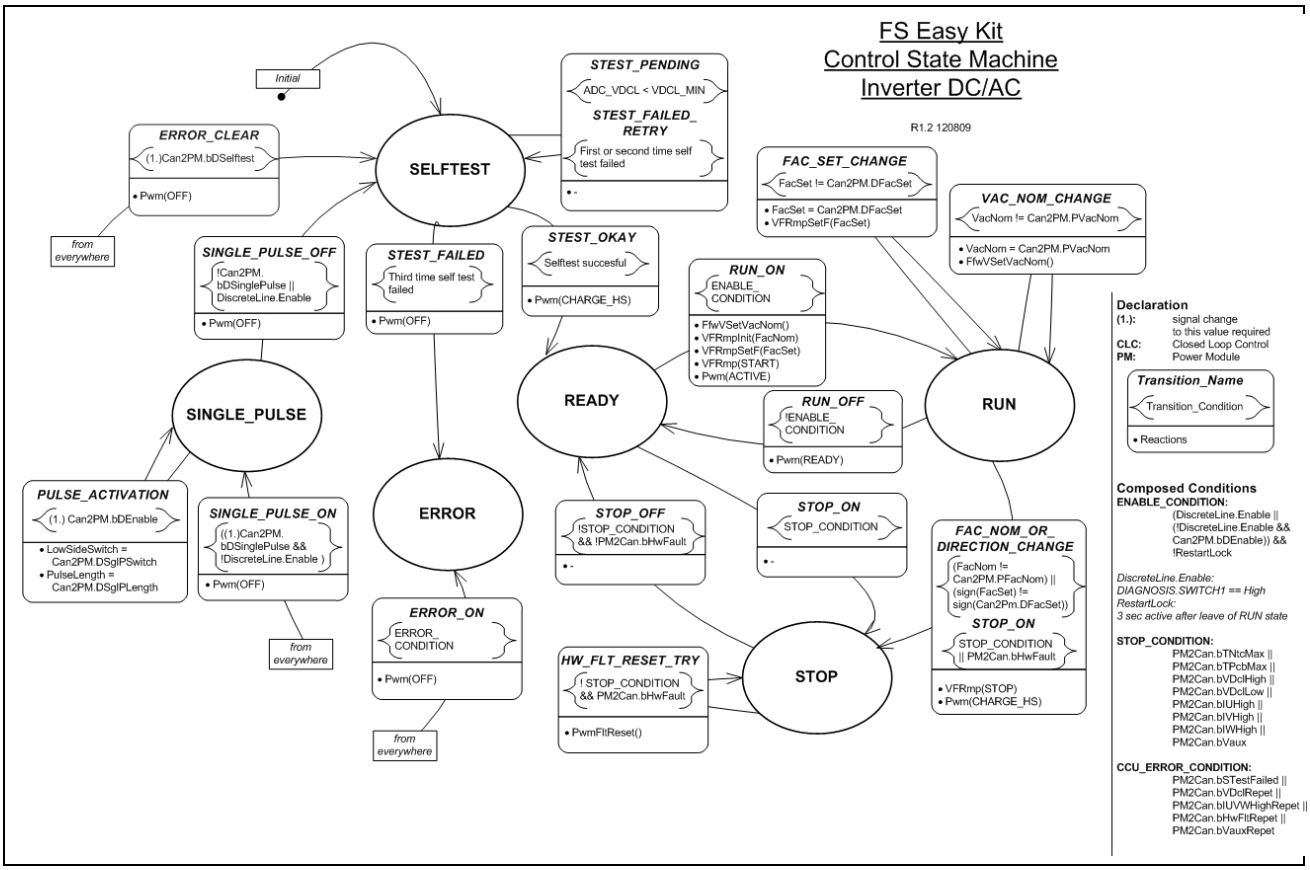


Figure 10 Control state machine of the Evaluation Kit.

4.5 Self Test Sequence

A self test is implemented in the uC software, which is performed at each power up cycle of the control board. The Evaluation Kit will only start the normal operation, when the signals give reasonable values and the test sequence was performed successfully. The sequence, which is illustrated in Figure 11, has four major test procedures:

1. ADC value plausibility: Checks the supply voltages of the ADC
2. ADC value limits: Checks the offsets of the sensors and ADC values
3. Low side switching: Switches sequentially all low side IGBTs and checks currents and voltages
4. High side switching: Switches sequentially all high side IGBTs and checks currents and voltages

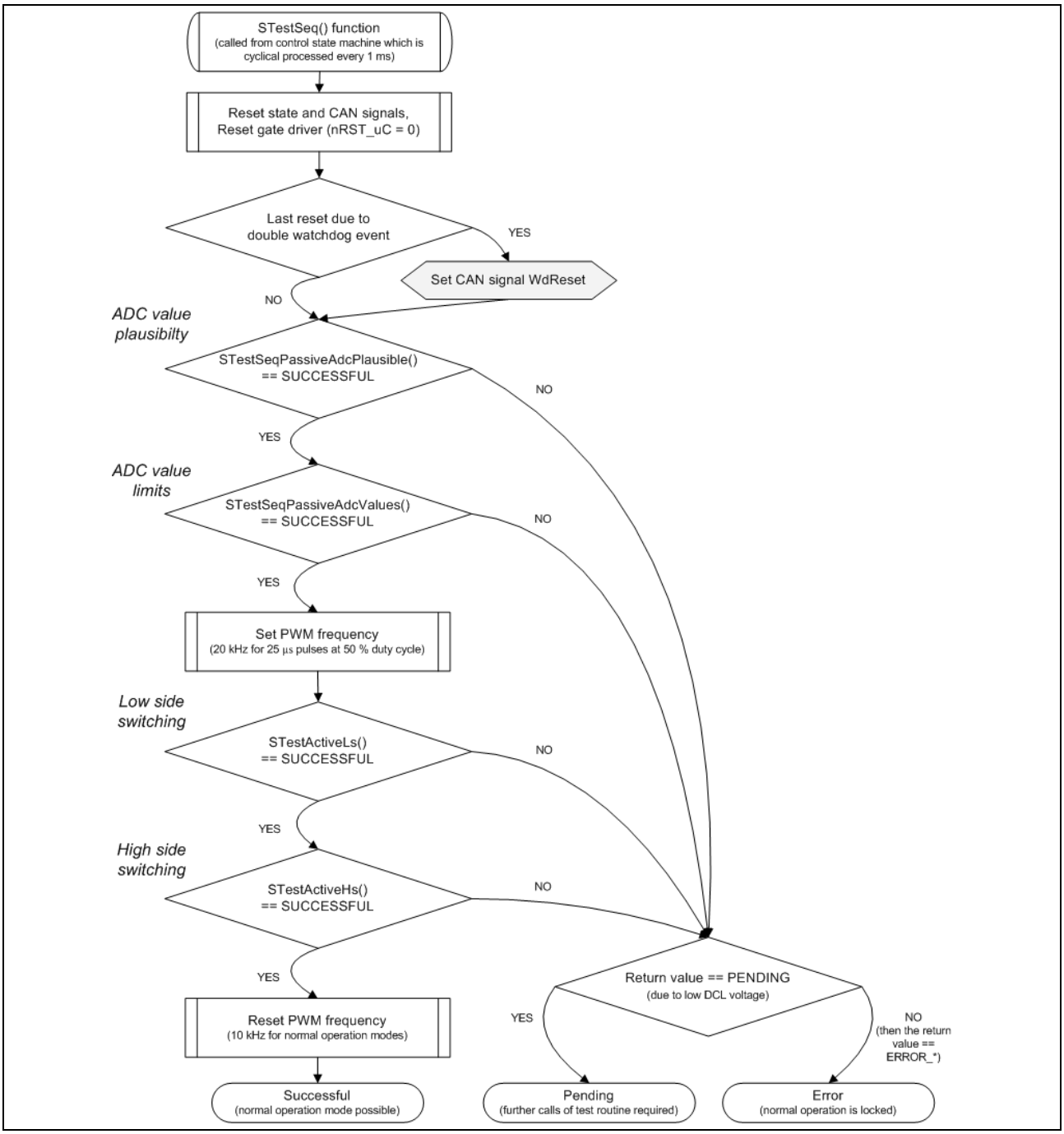


Figure 11 Overview of self test sequence with the four major test procedures.

The first part of the passive procedure checks the supply voltage of the uC and ADC. The ADC_1V95 signal is connected to the uC supply status led, which has a quite stable voltage drop of 1.95V over wide supply voltages. In case of drifts of the uC supply voltage, the ADC scaling of all sensors would not be correct. But such a drift will be detected because in such cases the ADC_1V95 signal is also distorted and out of range.

After this test the test procedure waits for a DCL voltage higher than 20V. This is required because the later switching tests makes no sense if the switch and phase voltages has always 0V Vce.

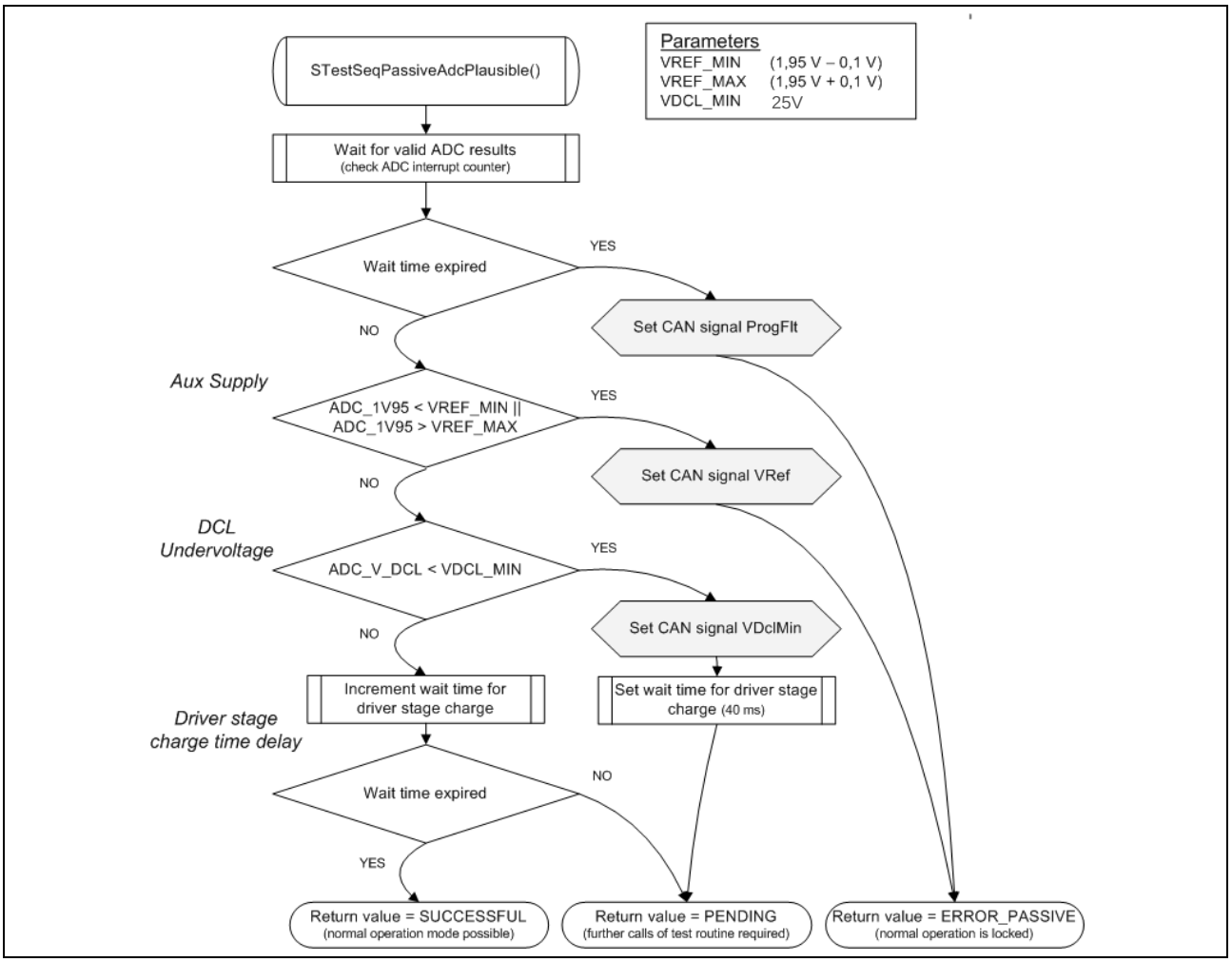


Figure 12 Overview of the passive self test sequence. Part 1 to check ADC values on plausibility.

The second part of the passive procedure checks the temperatures of the PCB and Module and cancels small current sensor offsets. The test procedure with the following switching test is only started if the Evaluation Kit is not in overvoltage lookout condition.

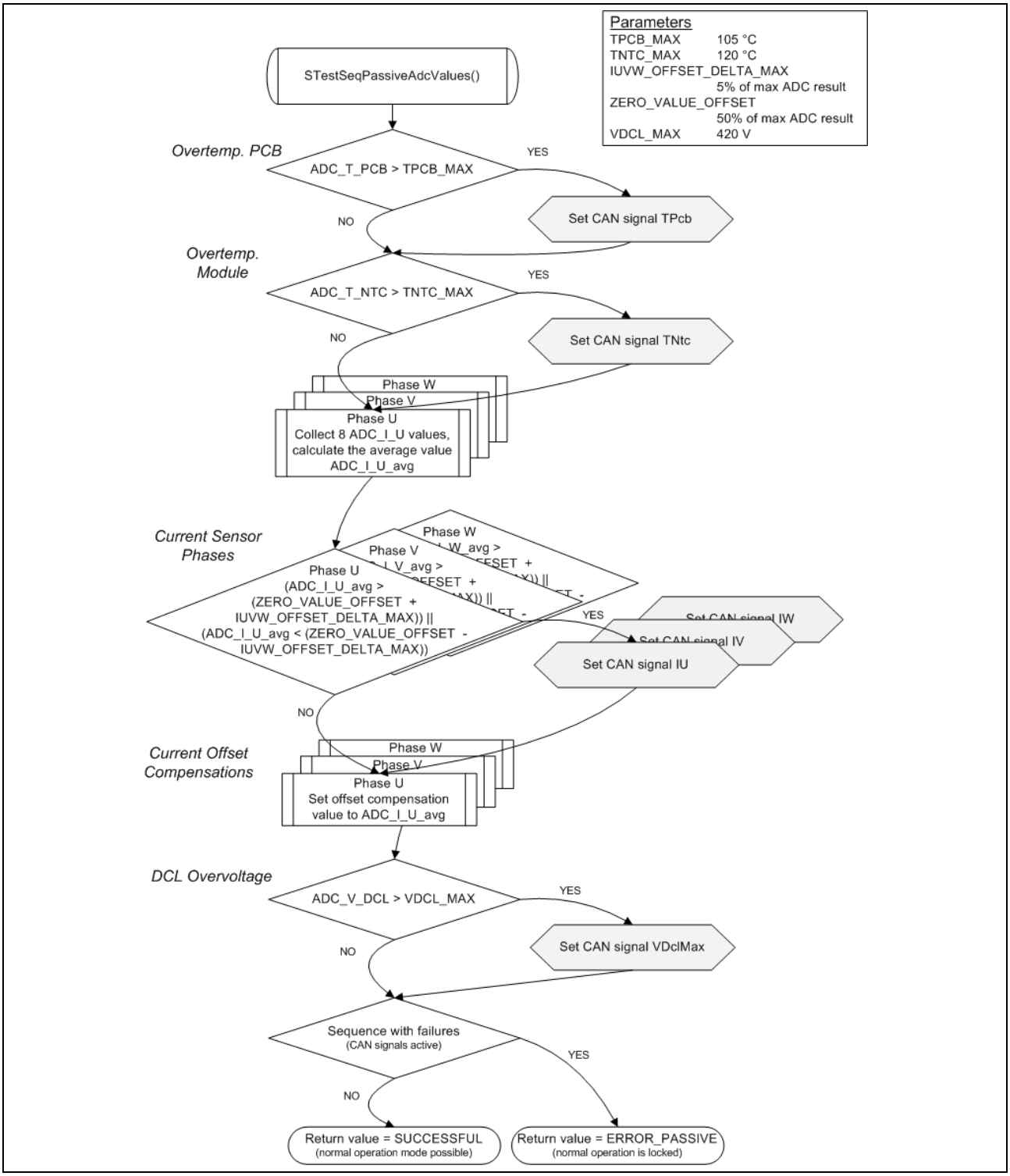


Figure 13 Overview of the passive self test sequence. Part 2 to check ADC limit values.

The passive tests are followed by switching tests of low side switches (see Figure 14) and high side switches (see Figure 15). Each switch is turned-on and Vce voltage, low side phase current, DCL voltage, and gate driver fault condition is checked for proper values. After this the switch is turned-off again.

After the test is successfully passed the default condition is than all low side switches turned-on. This enables the supply of the high side gate drivers, which are implemented via bootstrap supply.

The same test procedure of the low side switches is than performed with the high-side switches, whereby the corresponding low side switch is turned-off before.

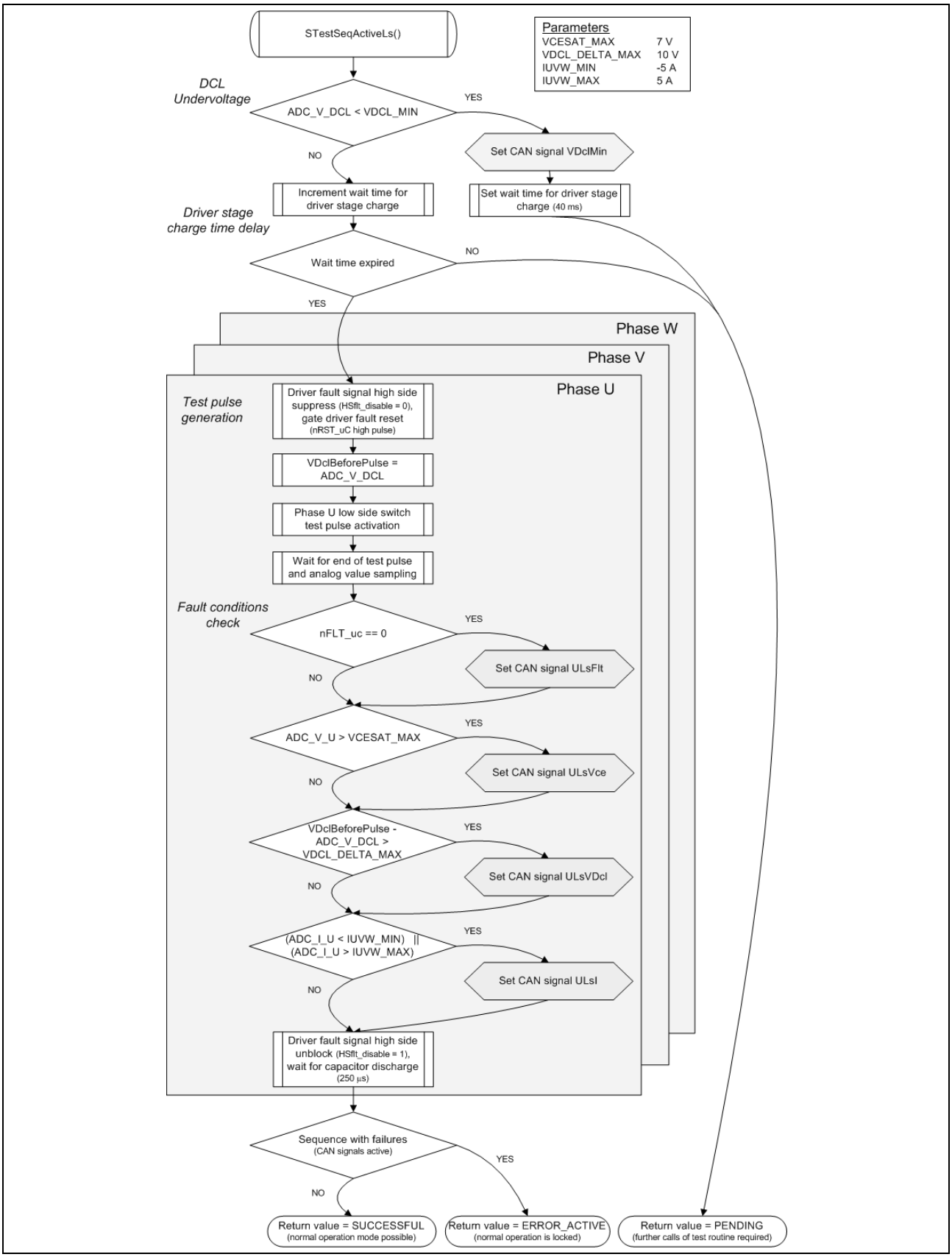

STestSeqActiveLs()
Parameters
VCESAT_MAX 7 V
VDCL_DELTA_MAX 10 V
IUVW_MIN -5 A
IUVW_MAX 5 A
DCL Undervoltage
ADC_V_DCL < VDCL_MIN
YES
NO
Set CAN signal VDclMin
Increment wait time for driver stage charge
Set wait time for driver stage charge (40 ms)
Driver stage charge time delay
Wait time expired
NO
YES
Phase W
Phase V
Phase U
Test pulse generation
Driver fault signal high side suppress (HSflt_disable = 0), gate driver fault reset (nRST_uC high pulse)
VDclBeforePulse = ADC_V_DCL
Phase U low side switch test pulse activation
Wait for end of test pulse and analog value sampling
Fault conditions check
nFLT_uc == 0
Set CAN signal ULsFlt
ADC_V_U > VCESAT_MAX
Set CAN signal ULsVce
VDclBeforePulse - ADC_V_DCL > VDCL_DELTA_MAX
Set CAN signal ULsVDcl
(ADC_I_U < IUVW_MIN) || (ADC_I_U > IUVW_MAX)
Set CAN signal ULsI
Driver fault signal high side unblock (HSflt_disable = 1), wait for capacitor discharge (250 µs)
Sequence with failures (CAN signals active)
YES
NO
Return value = SUCCESSFUL (normal operation mode possible)
Return value = ERROR_ACTIVE (normal operation is locked)
Return value = PENDING (further calls of test routine required)

Figure 14 Overview of the active self test sequence. Part 1 to check the low-side switches.

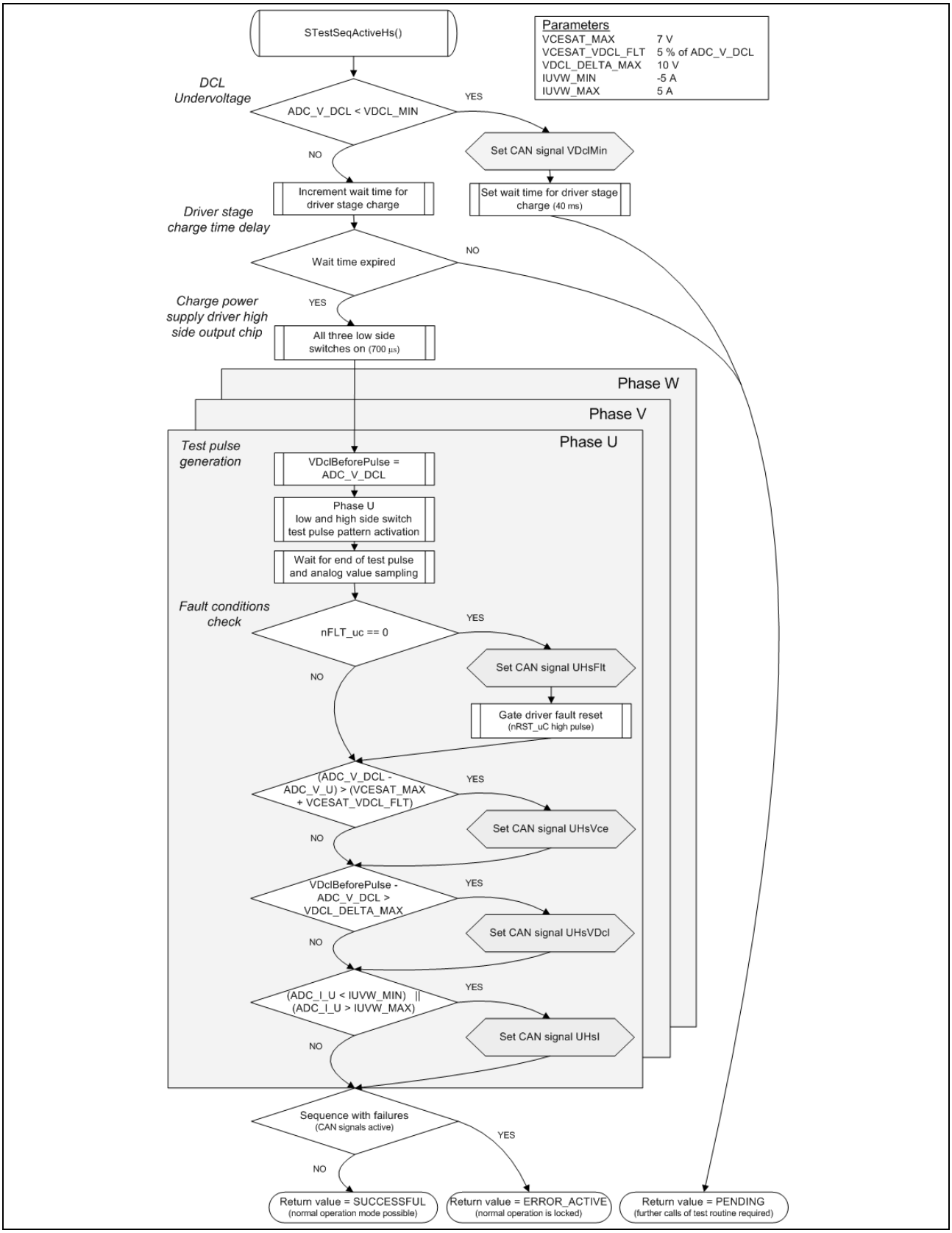


Figure 15 Overview of the active self test sequence. Part 2 to check the high-side switches.

4.6 Motor Control (U/f) Concept

The implemented simple U/f control concept is shown in Figure 16. The nominal frequency (FacNom) and voltage (VacNom) has to be adjusted to the specific motor. Higher output frequency than the nominal motor frequency enters the field weakening area.

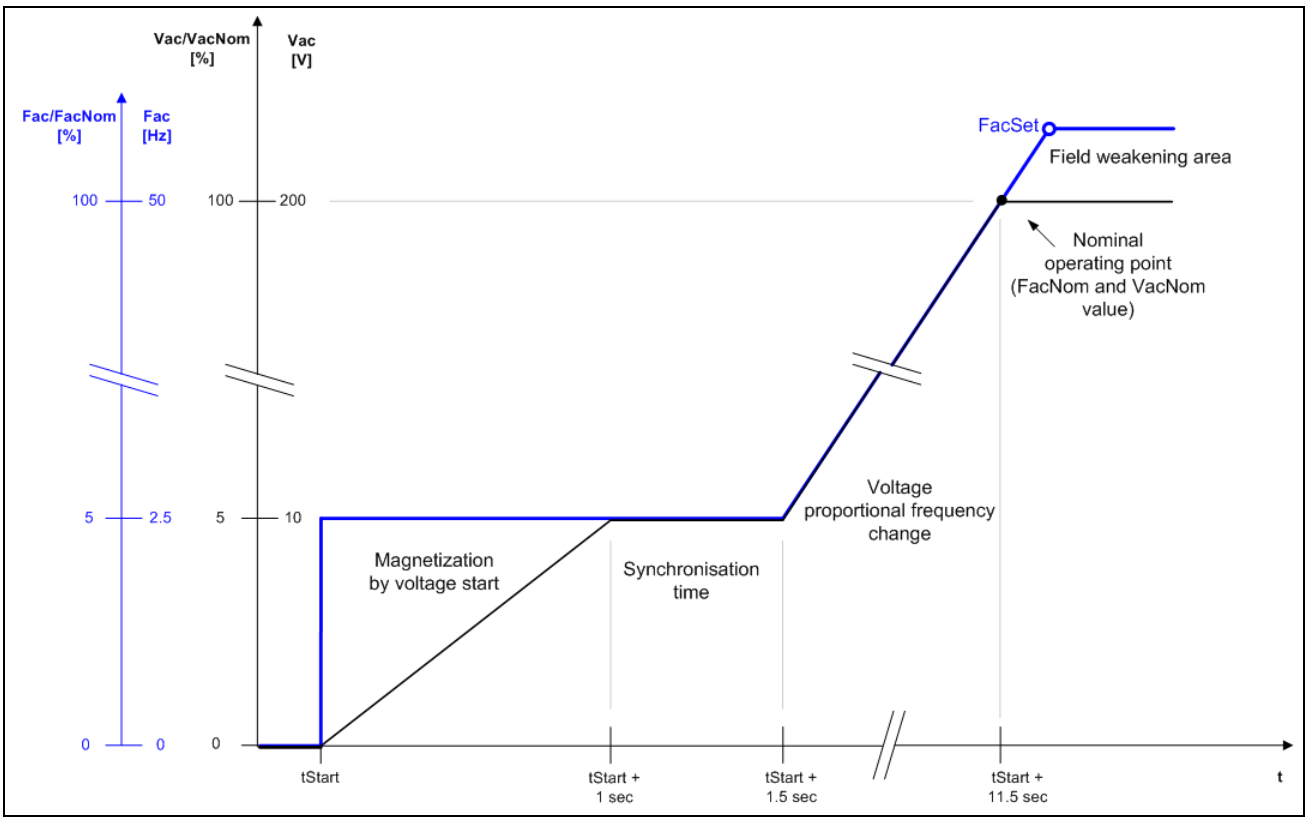


Figure 16 Motor control with U/f.

5 Evaluation Kit CAN Terminal

5.1 Introduction and Feature Description

The Evaluation Kit has a CAN communication functionality, which can be used with all standard HighSpeed CAN toolsets (1MBit/s). This CAN communication is isolated from the high voltage potentials. The CAN Terminal option via the Infineon UConnect XC2xxxX hardware provides a low cost gateway from the EASYKIT CAN port to a standard USB port (virtual COM).

With the CAN Terminal it is possible to control the EASYKIT in the CAN controlled mode with e.g. the following functionality:

- Adjust nominal motor parameters
- Adjust motor speed
- Monitor analog values and fault events from the EASYKIT
- Monitor communication states
- Perform single pulse tests

The main advantage for the customer is the low cost of this CAN Terminal solution compared to standard CAN cards available on the market. No specific SW installations are required on the target PC only a standard terminal program is required, which are available free of charge on the internet (e.g. Tera Term, PUTTY,….). Please note that the update rate is limited compared to standard CAN communication interfaces.

5.2 CAN Terminal Quick Start Guide

The following steps are required to setup the CAN Terminal function:

1. Connect UConnect stick on your PC
2. Install SW on uConnect stick (see section 5.3)
3. Jumper CAN Control Mode on EASYKIT (see Figure 8)
4. Connect UConnect to EASYKIT CAN
5. Open terminal program on PC (select COM port from UConnect and apply 115200 Baud) Note: please use or install a standard terminal program on your PC like Tera Term, PUTTY,…

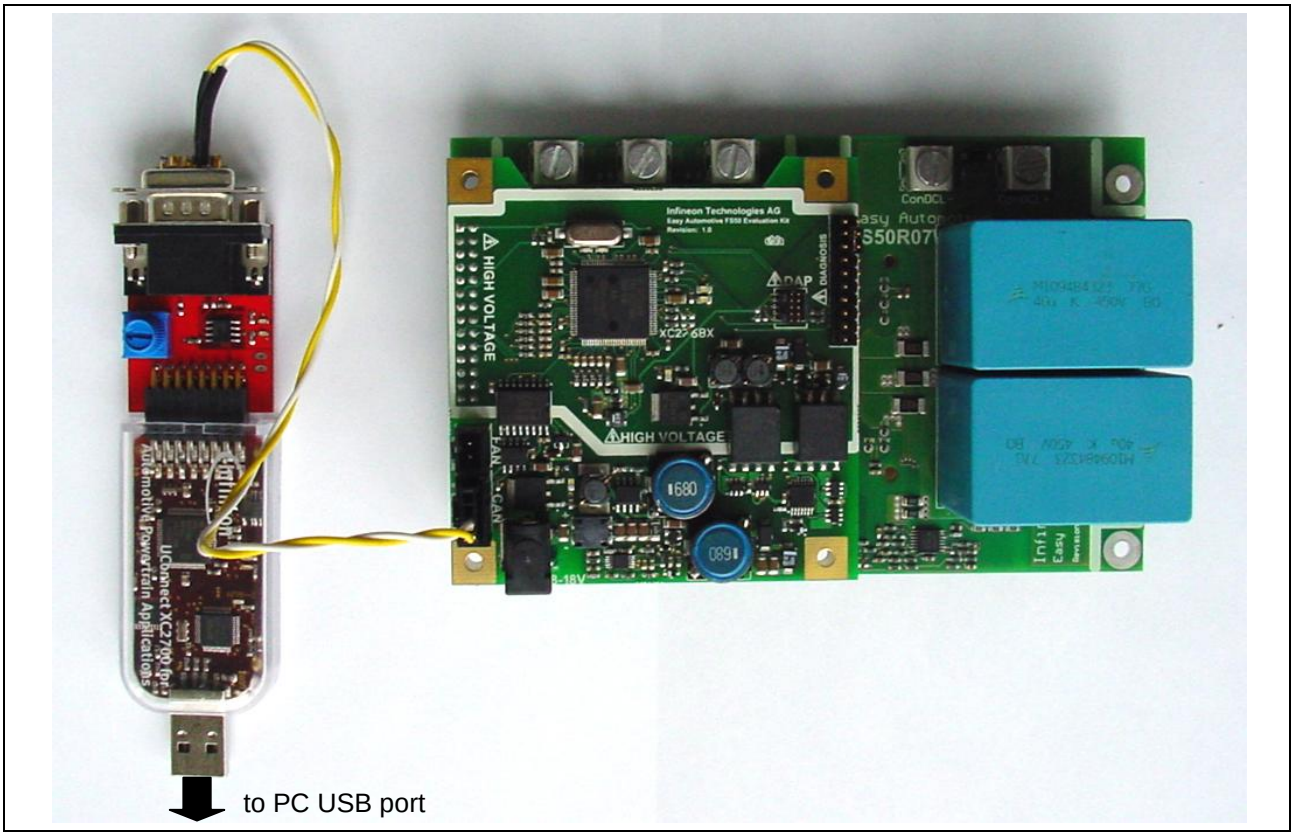


Figure 17 EASYKIT AUX DRIVES with UConnect stick to use the CAN terminal function. CANL is connected to D-SUB pin 2; CANH is connected to D-SUB pin7. Communication status is indicated with blinking blue led on UConnect stick.

5.3 How to install SW on UConnect stick

Before using the CAN Terminal via the Infineon UConnect stick a software has to be flashed into the UConnect microcontroller. The prepared SW is included in the shipped CD of the EASYKIT and can be found under “Software\Interface\uConnect” (see .hex file).

The easiest way to flash the microcontroller is given with the Infineon MEMTOOL. The latest version can be downloaded from http://www.infineon.com. A version can be also found on the delivery CD under “Software\Program\Memtool\”.

Now following steps are required at the first use:

1. Connect UConnect stick on your PC
2. Open Infineon Memtool on your PC
3. Select “Target/Change…” and select the .cfg configuration file from the delivery CD under “Software\Interface\uConnect”
4. Press Connect button (at bottom on GUI)
5. Select hex file from delivery CD “Software\Interface\uConnect”
6. Press Select All button
7. Press Add Select button
8. Press Program button
9. After press Disconnect button and target reset the program in UConnect stick starts

Now you can connect your UConnect stick to the EASYKIT CAN connector and open your terminal program on your PC. The CAN Terminal is now ready to use.

5.4 Using the CAN Terminal Feature

The CAN Terminal is a very simple and near self explaining user interface. After a correct installation and setup following overview screen will appear (see Figure 18).

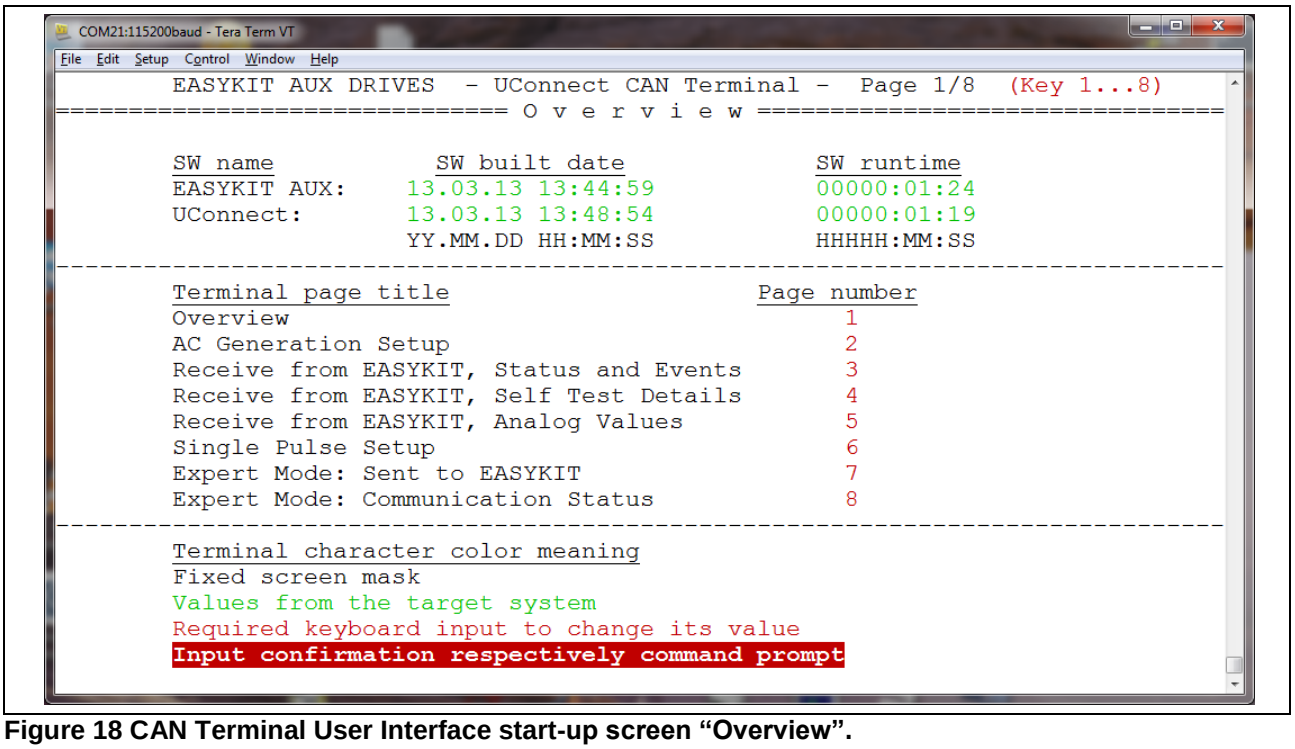

COM21:115200baud - Tera Term VT
File Edit Setup Control Window Help
EASYKIT AUX DRIVES - UConnect CAN Terminal - Page 1/8 (Key 1...8)
O v e r v i e w
SW name SW built date SW runtime
EASYKIT AUX: 13.03.13 13:44:59 00000:01:24
UConnect: 13.03.13 13:48:54 00000:01:19
YY.MM.DD HH:MM:SS HHHHH:MM:SS
Terminal page title Page number
Overview 1
AC Generation Setup 2
Receive from EASYKIT, Status and Events 3
Receive from EASYKIT, Self Test Details 4
Receive from EASYKIT, Analog Values 5
Single Pulse Setup 6
Expert Mode: Sent to EASYKIT 7
Expert Mode: Communication Status 8
Terminal character color meaning
Fixed screen mask
Values from the target system
Required keyboard input to change its value
Input confirmation respectively command prompt

Figure 18 CAN Terminal User Interface start-up screen “Overview”.

The pages can be changed with Key 1 to 8. The motor drive page is on page 2 “AC Generation Setup” (see Figure 19). In this page the nominal motor parameters can be adjusted (e.g. press key “d” for adjusting the

nominal motor voltage phase to phase and type new voltage value – press enter to activate new value. The new value will be shown under the Feedback value column if value is accepted successfully from the EASYKIT. Other parameters, which are shown on the Terminal can be adjusted simply in the same way.

If you want to perform single pulse tests you can switch to page 6 (see Figure 20). Adjust the pulse length (key “b” and type value in us) and select the switch were you want to perform the probe pulse (key “u” or “v” or “w”) and Activate low side single pulse (key “a”).

The other pages show further analog values, fault messages, communication status, self test details… and can give deeper details on the EASYKIT status.

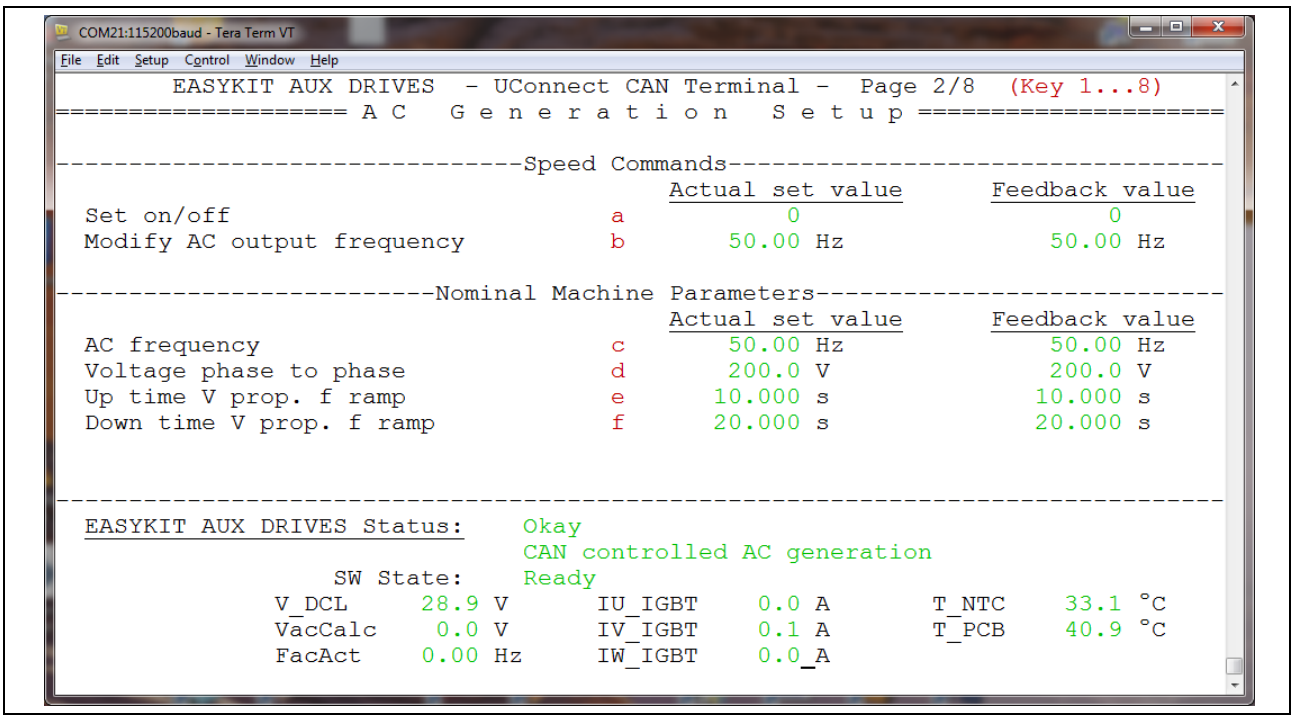

COM21:115200baud - Tera Term VT
File Edit Setup Control Window Help
EASYKIT AUX DRIVES - UConnect CAN Terminal - Page 2/8 (Key 1...8)
A C Generation Setup
Speed Commands
Actual set value Feedback value
Set on/off a 0 0
Modify AC output frequency b 50.00 Hz 50.00 Hz
Nominal Machine Parameters
Actual set value Feedback value
AC frequency c 50.00 Hz 50.00 Hz
Voltage phase to phase d 200.0 V 200.0 V
Up time V prop. f ramp e 10.000 s 10.000 s
Down time V prop. f ramp f 20.000 s 20.000 s
EASYKIT AUX DRIVES Status: Okay
CAN controlled AC generation
SW State: Ready
V_DCL 28.9 V IU_IGBT 0.0 A T_NTC 33.1 °C
VacCalc 0.0 V IV_IGBT 0.1 A T_PCB 40.9 °C
FacAct 0.00 Hz IW_IGBT 0.0 A

Figure 19 CAN Terminal User Interface page 2 for motor control “AC Generation Setup”.

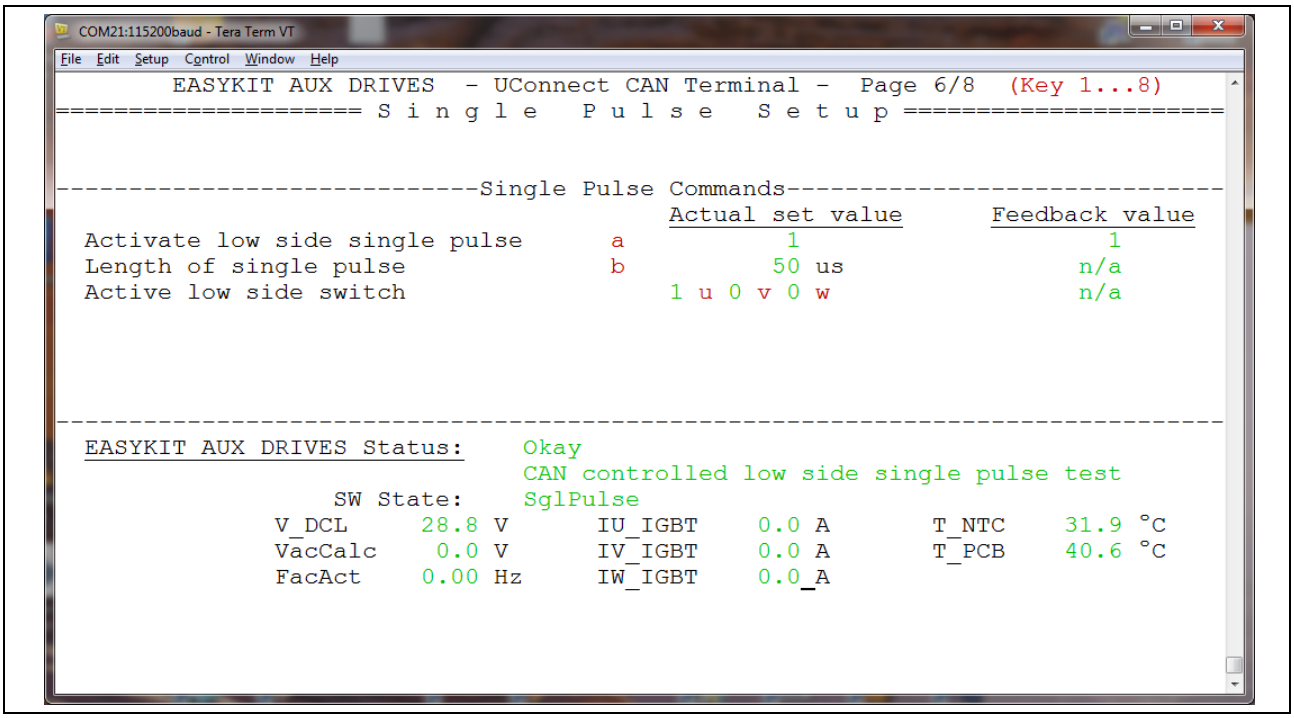

COM21:115200baud - Tera Term VT
File Edit Setup Control Window Help
EASYKIT AUX DRIVES - UConnect CAN Terminal - Page 6/8 (Key 1...8)
Single Pulse Setup
Single Pulse Commands
Actual set value
Feedback value
Activate low side single pulse a 1 1
Length of single pulse b 50 us n/a
Active low side switch 1 u 0 v 0 w n/a
EASYKIT AUX DRIVES Status: Okay
CAN controlled low side single pulse test
SW State: SglPulse
V_DCL 28.8 V
VacCalc 0.0 V
FacAct 0.00 Hz
IU_IGBT 0.0 A
IV_IGBT 0.0 A
IW_IGBT 0.0 A
T_NTC 31.9 °C
T_PCB 40.6 °C

Figure 20 CAN Terminal User Interface page 6 “Single Pulse Setup”.

6 Experimental Results

6.1 Test sequence

The test sequence concept was explained in Section 4.5. Figure 21 shows the measured waveforms from the mixed signal scope during the active switching part. The major events are numbered on the bottom of the screen shoot. Please take note that the phase voltages during switch turn-off phases can have different shapes depending on the connected load. However, when a switch is turned-on the Vce voltage of this switch has to be always low.

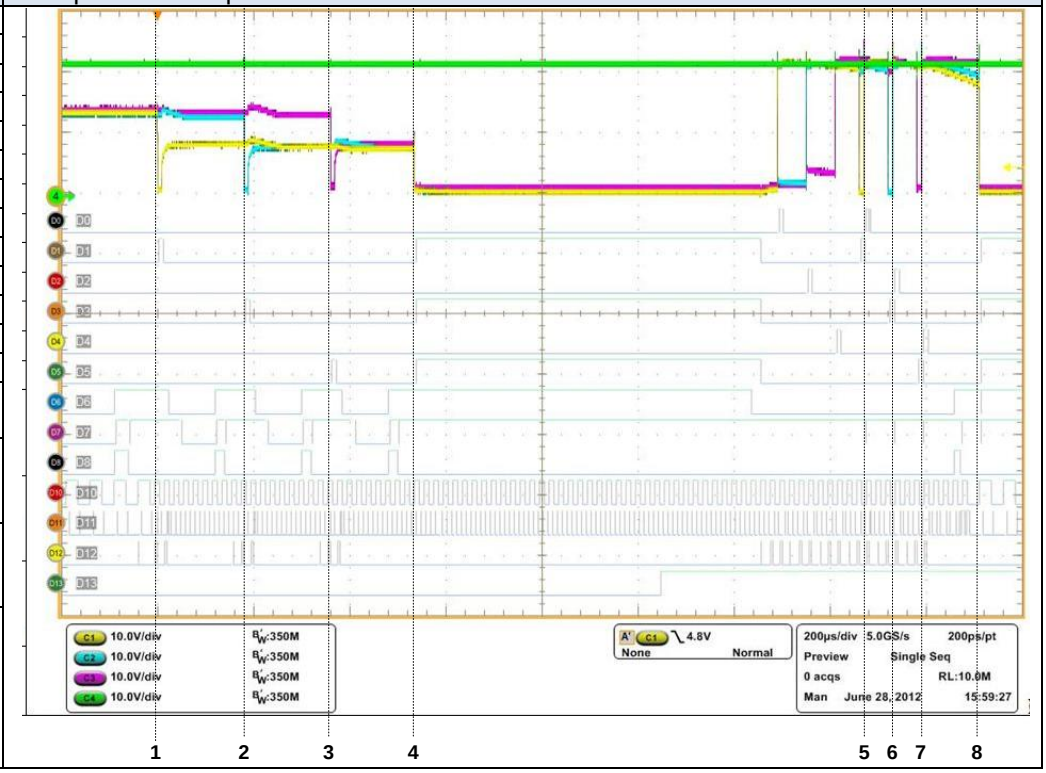
Legend	Complete test sequence
A1 V_U	
A2 V_V	
A3 V_W	
A4 V_DCL	
D0 PWM_UT	
D1 PWM_UB	
D2 PWM_VT	
D3 PWM_VB	
D4 PWM_WT	
D5 PWM_WB	
D6 HSflt_disable	
D7 nFLT_uC	
D8 nRST_uC	
D10 toggle at PWM timer period	
D11 ADC ISR & ADC value read at self test routine	
D12 PWM ISR code for test pulse generation	
D13 DRIVER_U /RSTHS	

Figure 21 Overview of the active self test sequence. Low side and high side switching.

1. The low side phase U switch is turned-on and off
2. The low side phase V switch is turned-on and off
3. The low side phase W switch is turned-on and off
4. The low side switching test is PASSED and all low side switches are turned-on (default wait state)
5. The high side phase U switch is turned-on and off (after low side switch turn-off)
6. The high side phase V switch is turned-on and off (after low side switch turn-off)
7. The high side phase W switch is turned-on and off (after low side switch turn-off)
8. The high side switching test is PASSED and all low side switches are turned-on (default wait state). The test sequence is successfully PASSED

6.2 Short Circuit Tests

Short circuits can be considered as most critical events for an inverter. Two different types of short circuits were tested with the Evaluation KIT. Short circuit I is a short circuit close to the power module (e.g. on the power connectors) and thus has a low inductance. The short circuit II appears in the system if e.g. the motor windings generate a short.

The following tests were performed at 25°C, where higher short circuit currents and faster switching characteristics (voltage overshoot) is achieved compared to Tj=150°C.

6.2.1 Short Circuit I (low inductance)

The power terminal of the phase output was directly connected to the DCL+ terminal. A current probe was inserted in the short circuit cable to measure the currents of this short circuit (IL). The equivalent circuit during this test is shown in Figure 22.

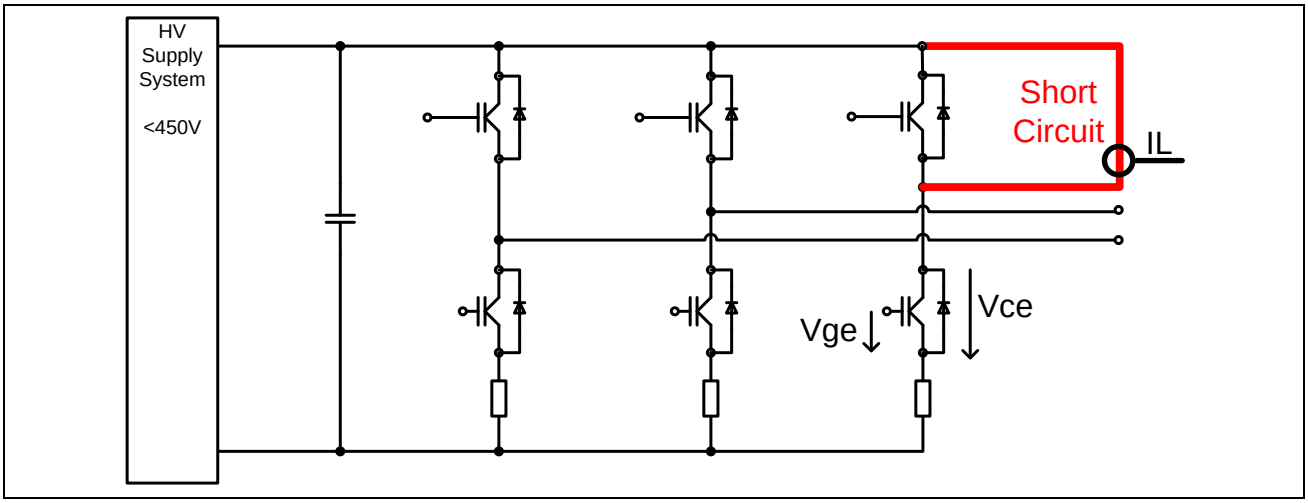


Figure 22 Equivalent circuit of the short circuit I test. The device under test is the right low-side switch.

Figure 23 shows the measured waveforms of the IGBT (see Vce and Vge) and the short circuit current (IL). The IGBT turns-on at 0 us. After approx 0.4 us the current is high enough that the IGBT desatures (Vce voltage rises to high values despite the IGBT is still turned on). This desaturation is detected quite fast in the gate driving circuit, which turns-off the IGBT at approx 1.5us. The turn-off overvoltage with <100V is relatively low. All measured values were within the specification of the F4-50R07W1E3_B11A power module.

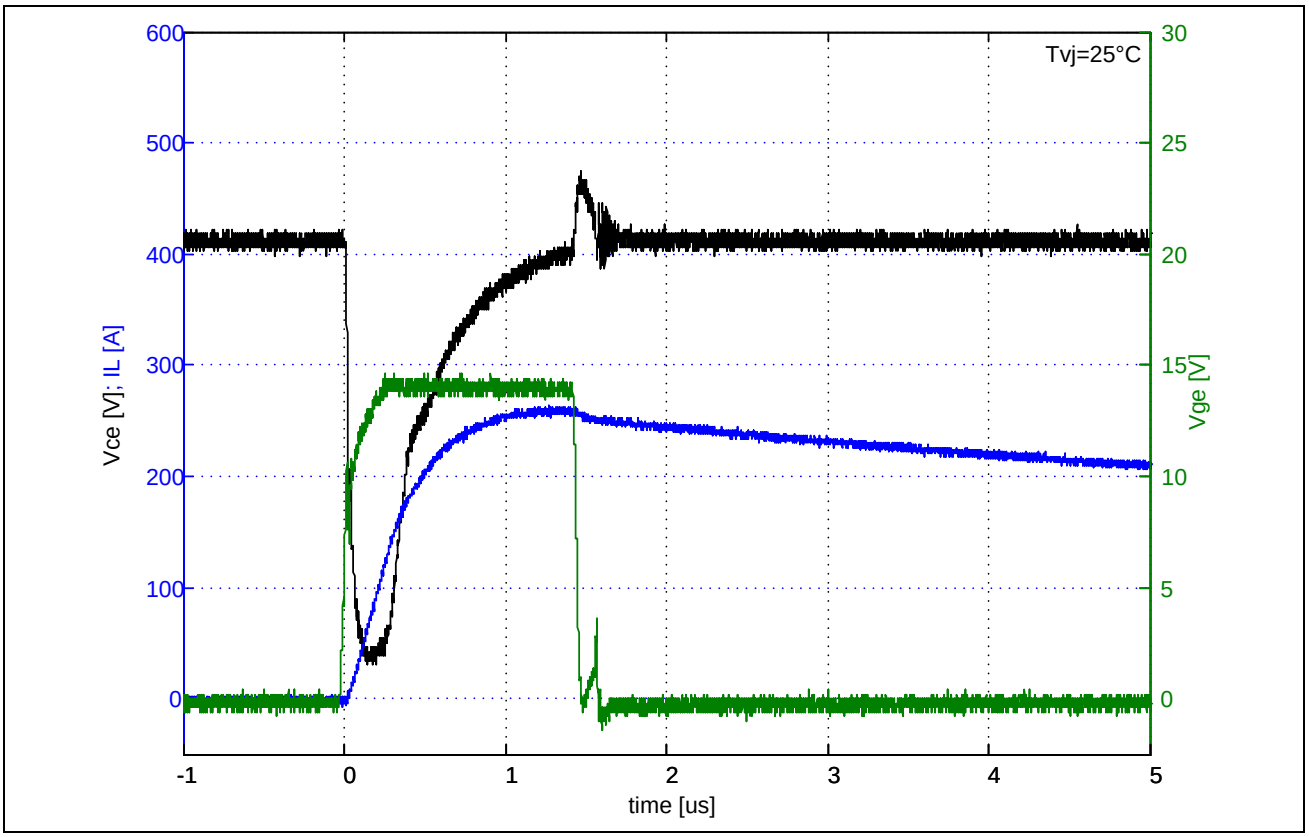


Figure 23 Measured waveforms of the DUT during the short circuit test. See Figure 22 for measurement points.

6.2.2 Short Circuit II (high inductance)

An inductance between the power terminal of the phase output and the DCL+ terminal was inserted for the short circuit II tests. A current probe measures again the currents of this short circuit (IL). The equivalent circuit during this test is shown in Figure 24.

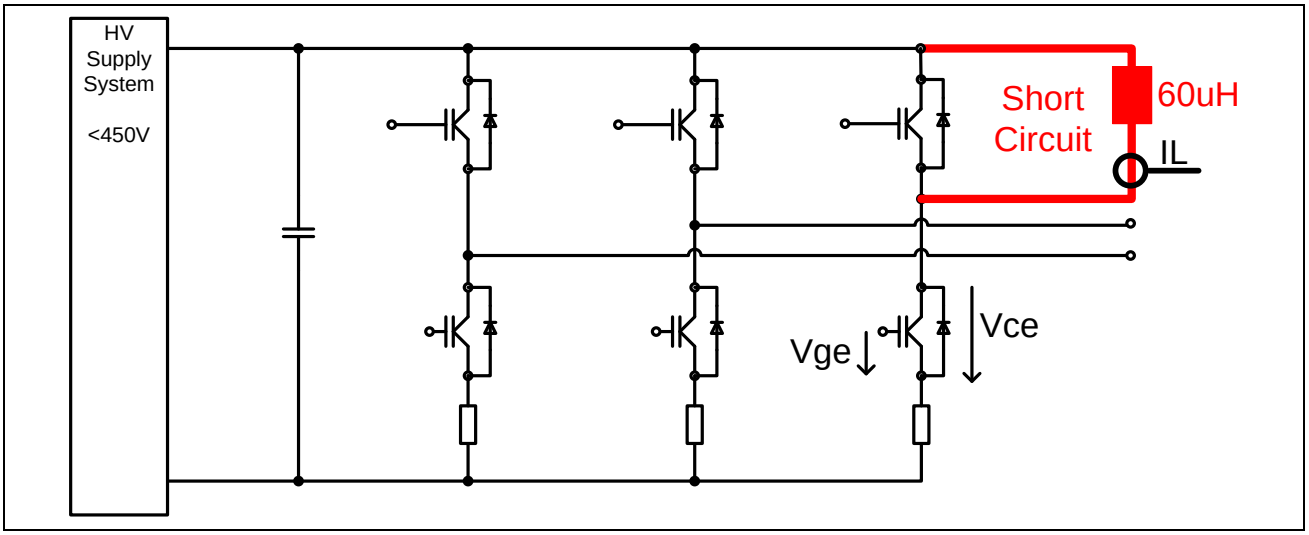


Figure 24 Equivalent circuit of the short circuit II test. The device under test is the right low-side switch.

Figure 25 shows the measured waveforms of the IGBT (see Vce and Vge) and the short circuit current (IL). The IGBT turns-on at 0 us. Due to the short circuit inductance the current rises relatively low. After approx 16.5 us the current is high enough that the IGBT desatures (Vce voltage rises to high values despite the IGBT is still turned on). This desaturation is detected in the gate driving circuit, which turns-off the IGBT. The turn-off overvoltage with <100V is relatively low. All measured values were within the specification of the FS50R07W1E3_B11A power module.

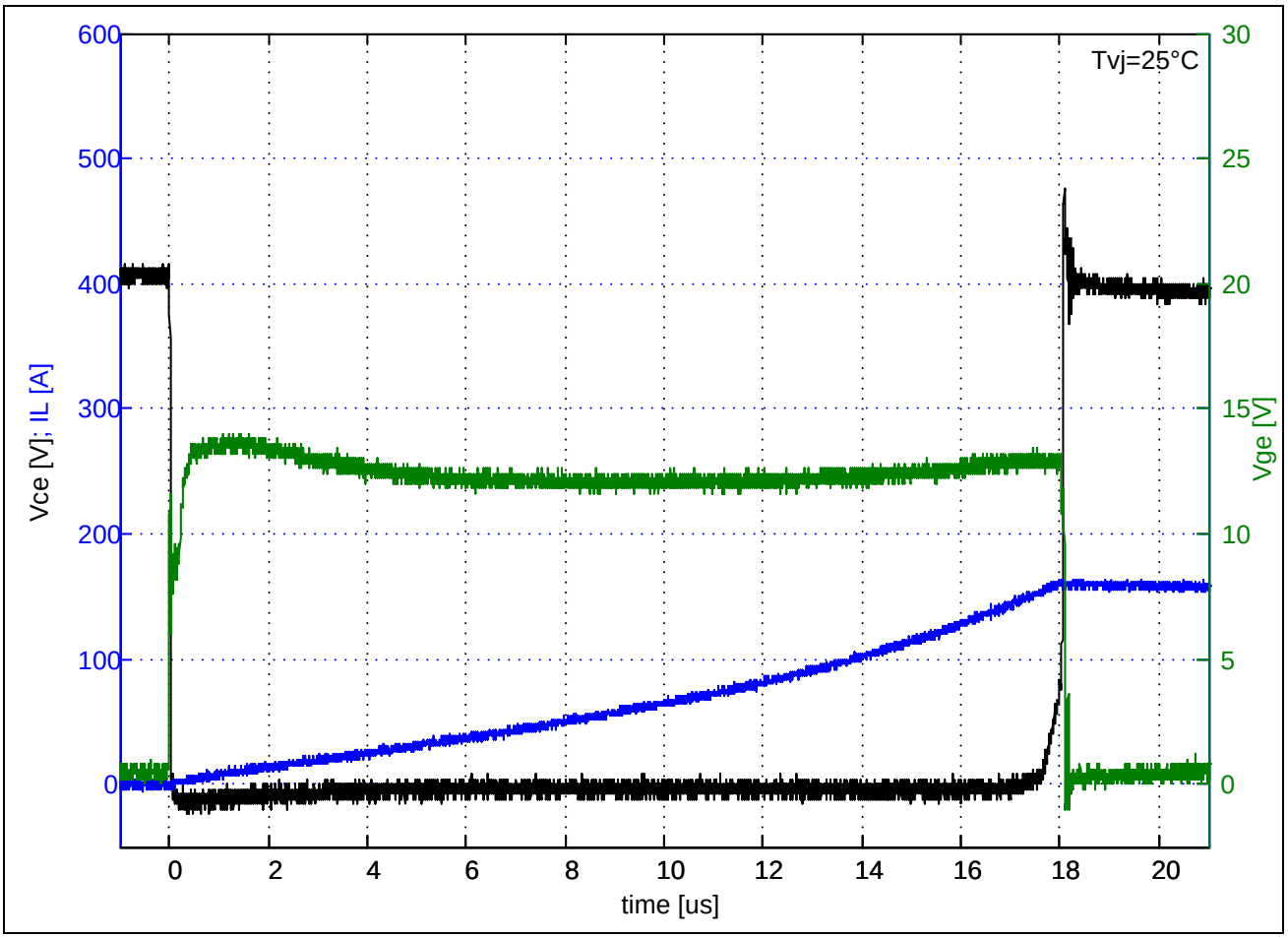


Figure 25 Measured waveforms of the DUT during the short circuit test. See Figure 22 for measurement points.

6.3 IGBT Turn-off (300V, 25A, 150°C)

The simplified circuit of the IGBT turn-off testbench is shown in Figure 26. Please note that the environmental conditions are different from a standard characterization testbench, where the maximum module performance is characterized. The gate driver has in this setup +15V/0V supply and Rg,off=2.2Ω. No booster stage is implemented. The gate driver achieves in this case ≈1.7A peak current. The IGBT module and gate driver circuit has no clamping circuits to limit Vce overshoot.

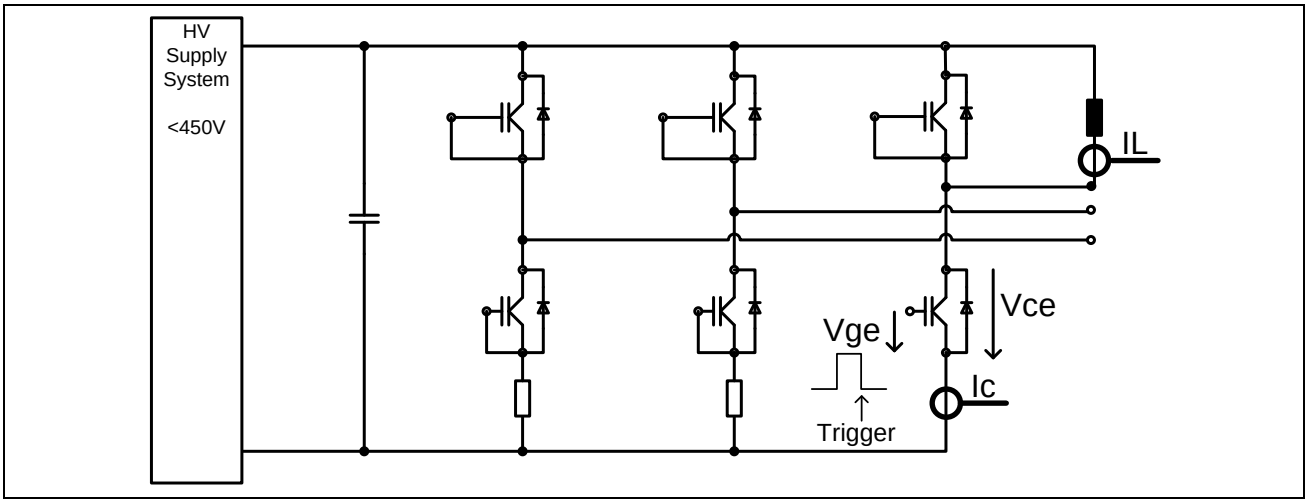


Figure 26 Equivalent circuit of the IGBT turn-off testbench. DUT is the low right IGBT. The low side shunt is bridged and the current Ic is measured with a Rogowski current probe.

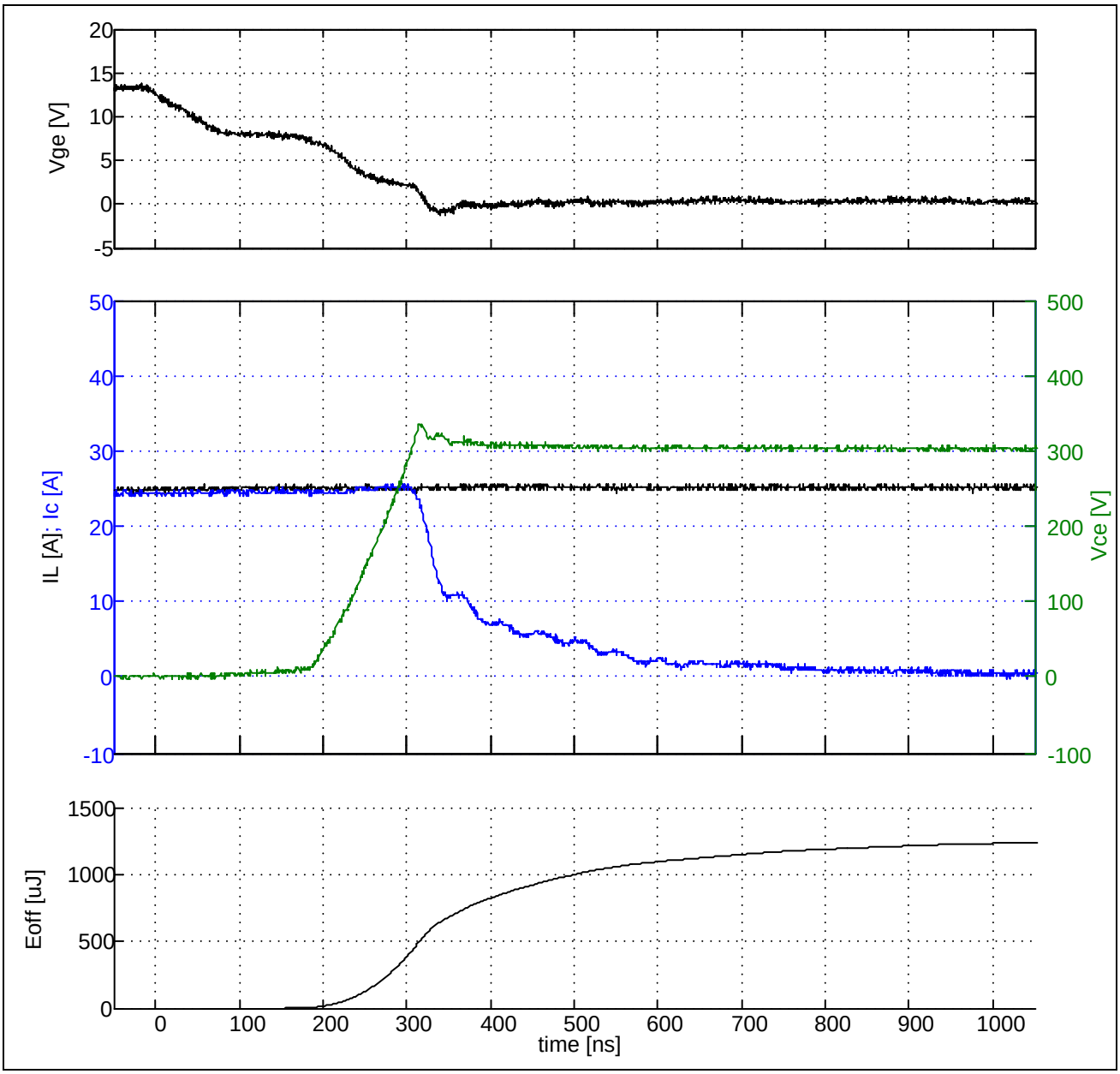


Figure 27 IGBT turn-off at 300V, 25A and Tvj=150°C. Vge=+15V/0V with Rg,off=2.2Ω.

Table 1 Measurement results during IGBT turn-off (300V, 25A, 150°C)

Symbol	Unit	Value	Description
tdoff	ns	320	Turn-off delay time: 90% Vge to 90% Ic
tf	ns	250	Fall time: 90% Ic to 10% Ic
Eoff	mJ	1.19	Turn-off energy loss per pulse: 10% Vce to 2% Ic
dV/dt	kV/us	2.7	Voltage slew rate: 50% Vce to 90% Vce
di/dt	kA/us	-0.49	Current slew rate: 90% Ic to 50% Ic
dV	V	37	Voltage overshoot (Vce,max-Vce,high)

6.3.1 IGBT Turn-on (300V, 25A, 150°C)

The simplified circuit of the IGBT turn-on testbench is shown in Figure 28. Please note that the environmental conditions are different from a standard characterization testbench, where the maximum module performance is characterized. The gate driver has in this setup +15V/0V supply and Rg,on=2.2Ω. No booster stage is implemented. The gate driver achieves in this case ≈0.7A peak current.

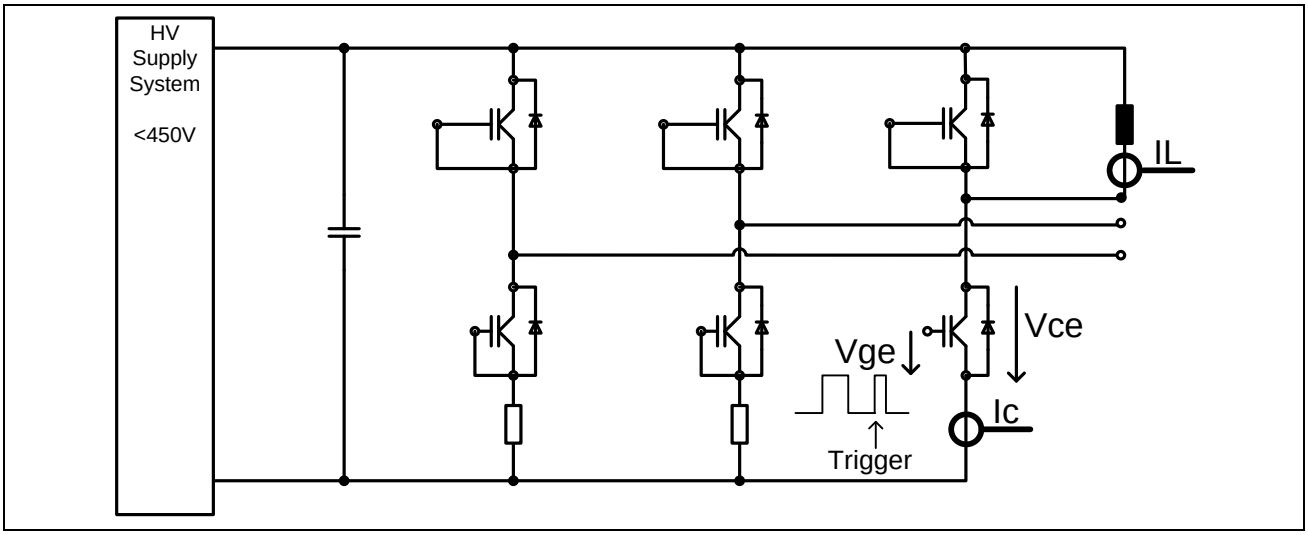


Figure 28 Equivalent circuit of the IGBT turn-on testbench. DUT is the low right IGBT. The low side shunt is bridged and the current Ic is measured with a Rogowski current probe. The waveforms are measured during the second turn-on pulse.

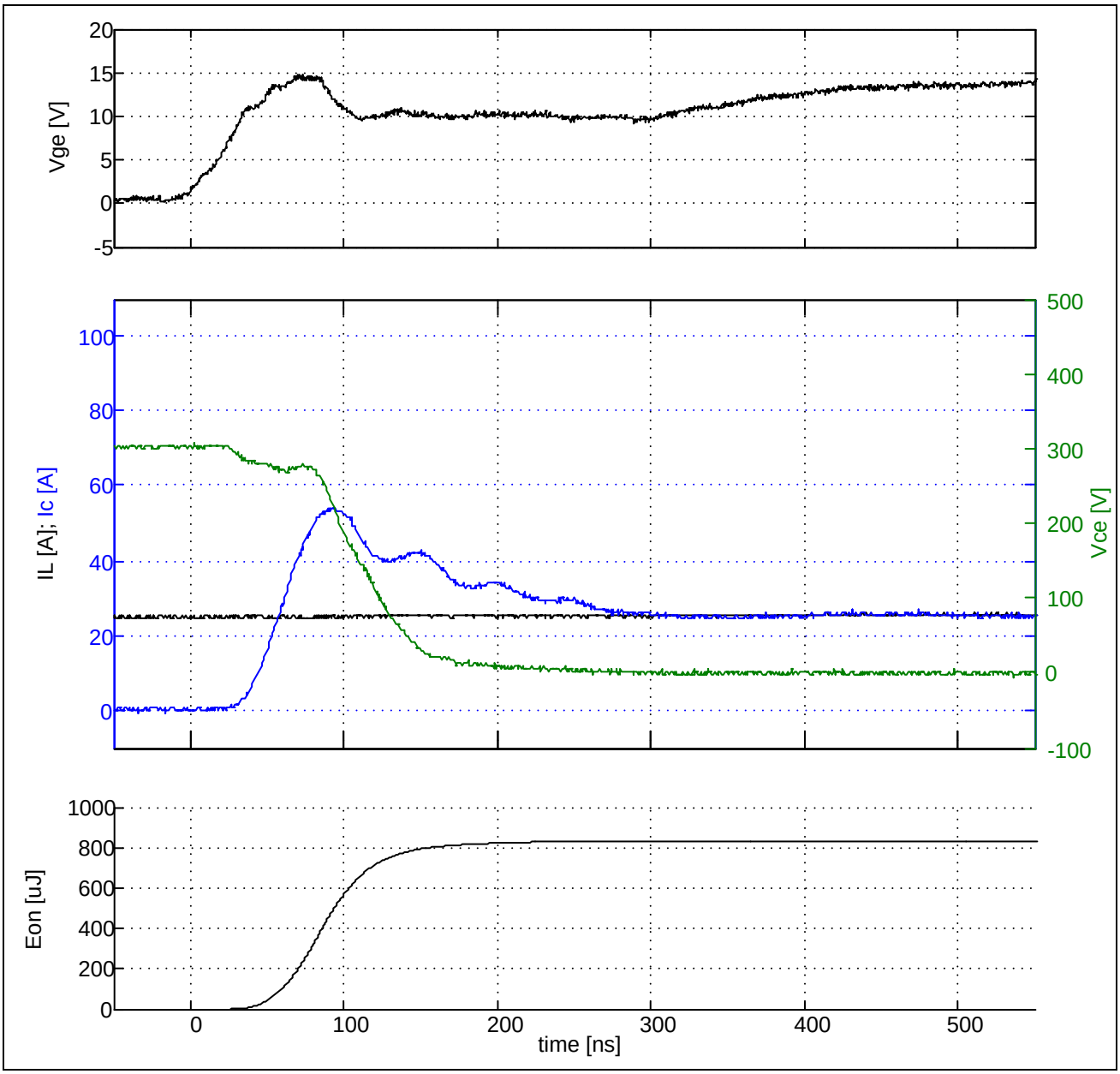


Figure 29 IGBT turn-on at 300V, 25A and Tvj=150°C. Vge=+15V/0V with Rg,on=2.2Ω.

Table 2 Measurement results during IGBT turn-on (300V, 25A, 150°C)

Symbol	Unit	Value	Description
tdon	ns	35	Turn-on delay time: 10% Vge to 10% Ic
tr	ns	45	Rise time: 10% Ic to 90% Ic
Eon	mJ	0.83	Turn-on energy loss per pulse: 10% Ic to 2% Vce
di/dt	kA/us	1.08	Current slew rate: 50% Ic to 90% Ic
dV/dt	kV/us	3.01	Voltage slew rate: 50% Vce to 10% Vce
dI	A	29	Current overshoot (Ic,max-Ic,high)
Ls	nH	30	System stray Inductance

6.3.2 Diode Turn-off (300V, 25A, 150°C)

The simplified circuit of the Diode turn-off testbench is shown in Figure 30. Please note that the environmental conditions are different from a standard characterization testbench, where the maximum module performance is characterized. The gate driver has in this setup +15V/0V supply and Rg,on=2.2Ω. No booster stage is implemented. The gate driver achieves in this case ≈0.7A peak current.

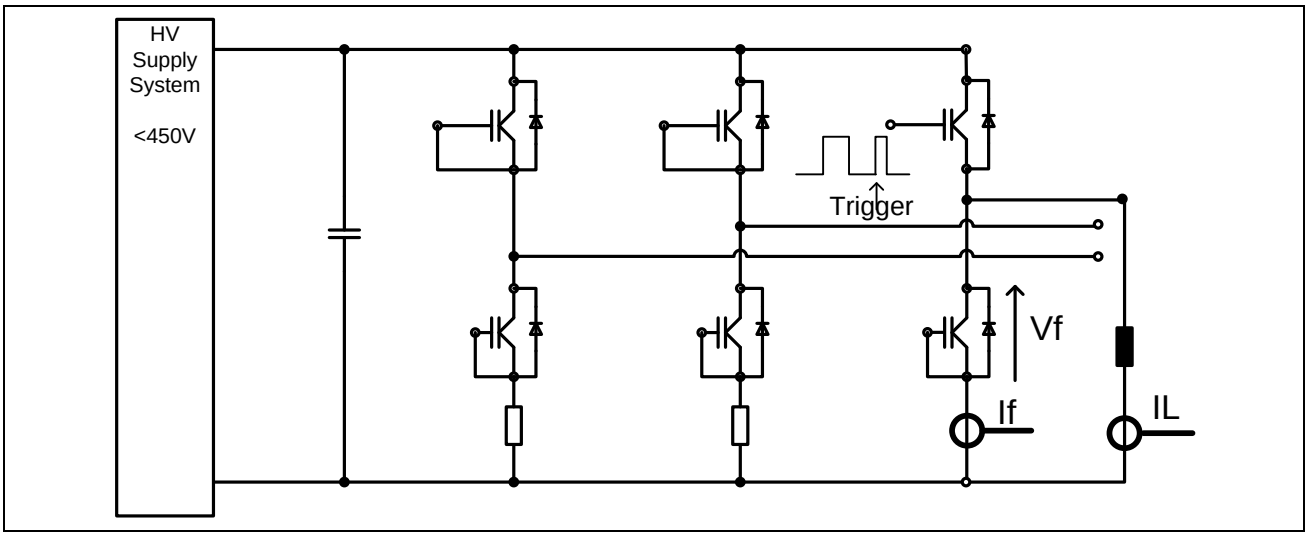


Figure 30 Equivalent circuit of the Diode turn-off testbench. DUT is the low right Diode. The low side shunt is bridged and the current If is measured with a Rogowski current probe. The waveforms are measured during the second turn-on pulse.

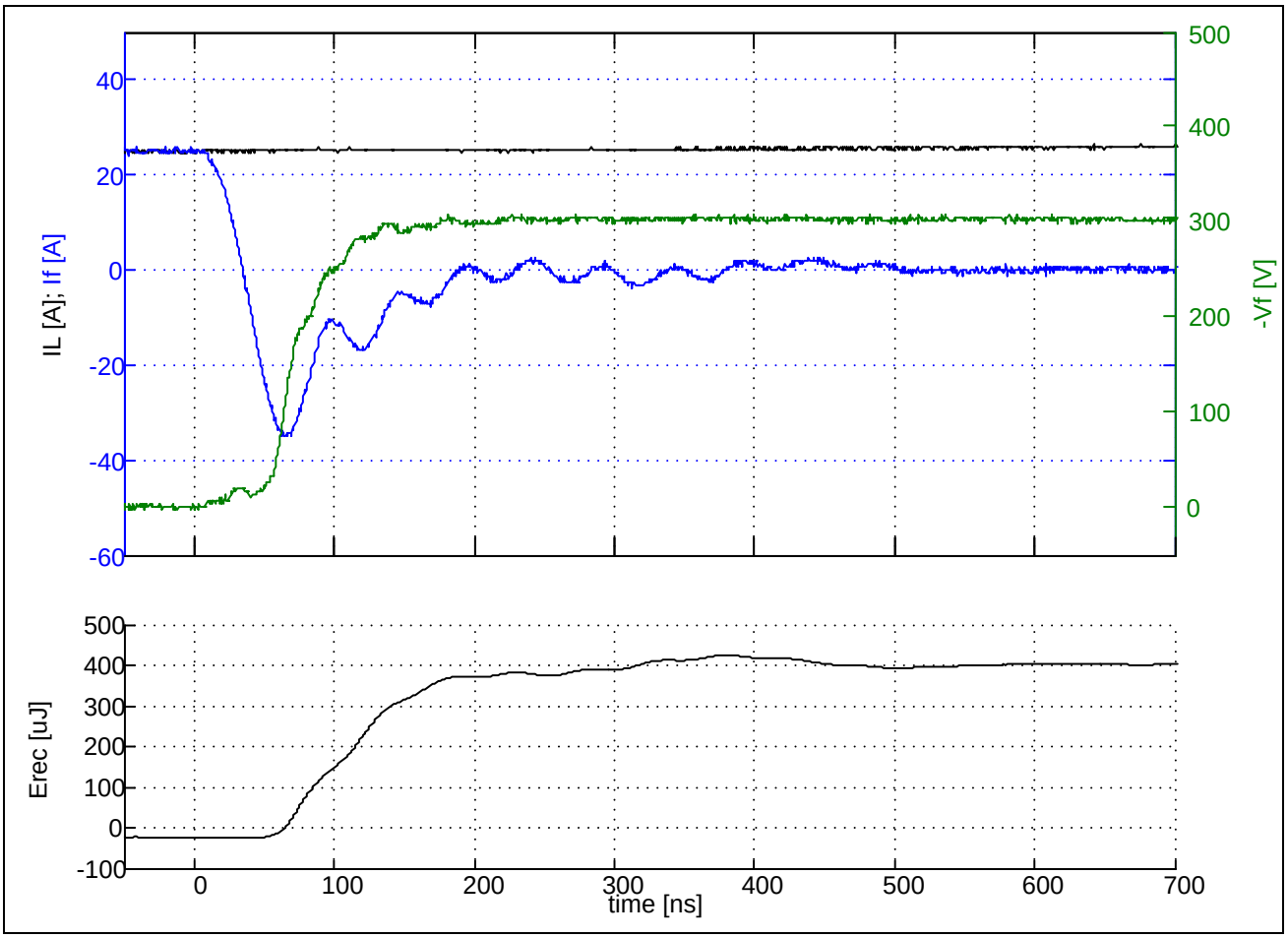


Figure 31 Diode turn-off at 300V, 25A and Tvj=150°C. Vge=+15V/0V with Rg,on=2.2Ω.

Table 3 Measurement results during Diode turn-off (300V, 25A, 150°C)

Symbol	Unit	Value	Description
Irm	A	35	Reverse recovery peak current
Erec	mJ	0.38	Turn-off energy loss per pulse: 10% Vf to 2% Irm
di/dt	kA/us	1.49	Current slew rate: 50% If to 50% Irm
Qrr	uC	2.21	Reverse recovery charge (int(Irm) min value to 2%Irm)
trr	ns	145	Reverse recovery time 10% Irm to 10%Irm

6.3.3 IGBT Turn-off (450V, 100A, 25°C)

The Evaluation Kit does not use anly clamping circuits to limit Vce overshoots. Therefore, an IGBT turn-off pulse at low temperature, max DCL voltage and collector current for switching operation has to be tested. Figure 32 shows the measured waveforms of this IGBT turn-off event. The voltage did not exceed 550V. The low current capability of the gate driving circuit and the unipolar supply had the disadvantage of higher switching energies. However, this test at high DCL voltage and collector current shows that active clamping measures to limit Vce voltage overshoots are not necessary in this Evaluation Kit.
Please take note that the overshoot characteristics strongly depends on many system parameters (PCB layout, DCL-capacitor, gate driving circuits, temperature,…) . These results in the Evaluation Kit should not be regarded as a general recommendation against active clamping measures.

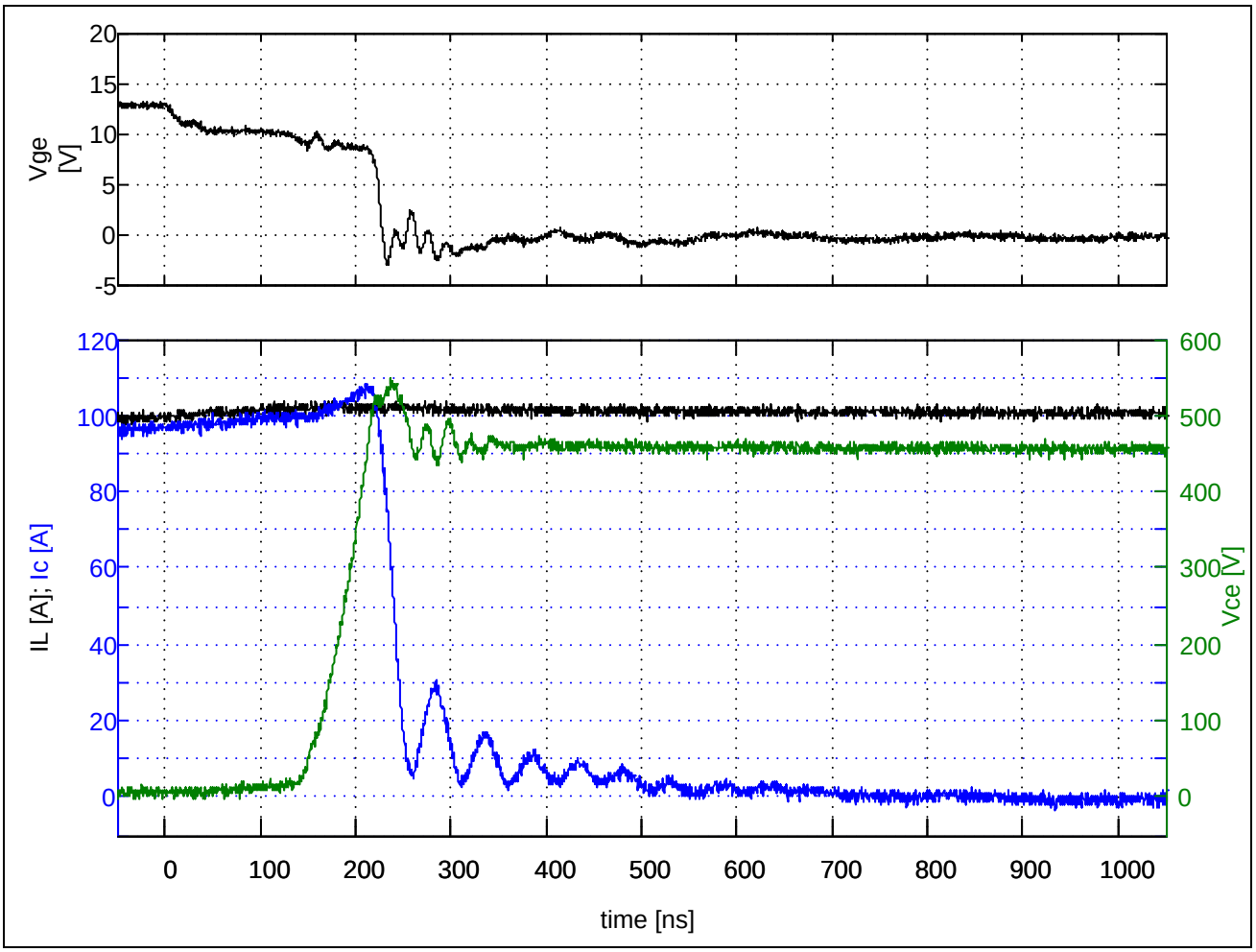


Figure 32 IGBT turn-off at 450V, 100A and Tvj=25°C. Vge=+15V/0V with Rg,off=2.2Ω. Vce clamping measures are not needed in this Evaluation Kit.

6.4 Motor run (Default Mode 1)

Figure 33 shows a scope screenshoot with all phase voltages, one phase current and the PWM signals on the digital channels D0..D5.

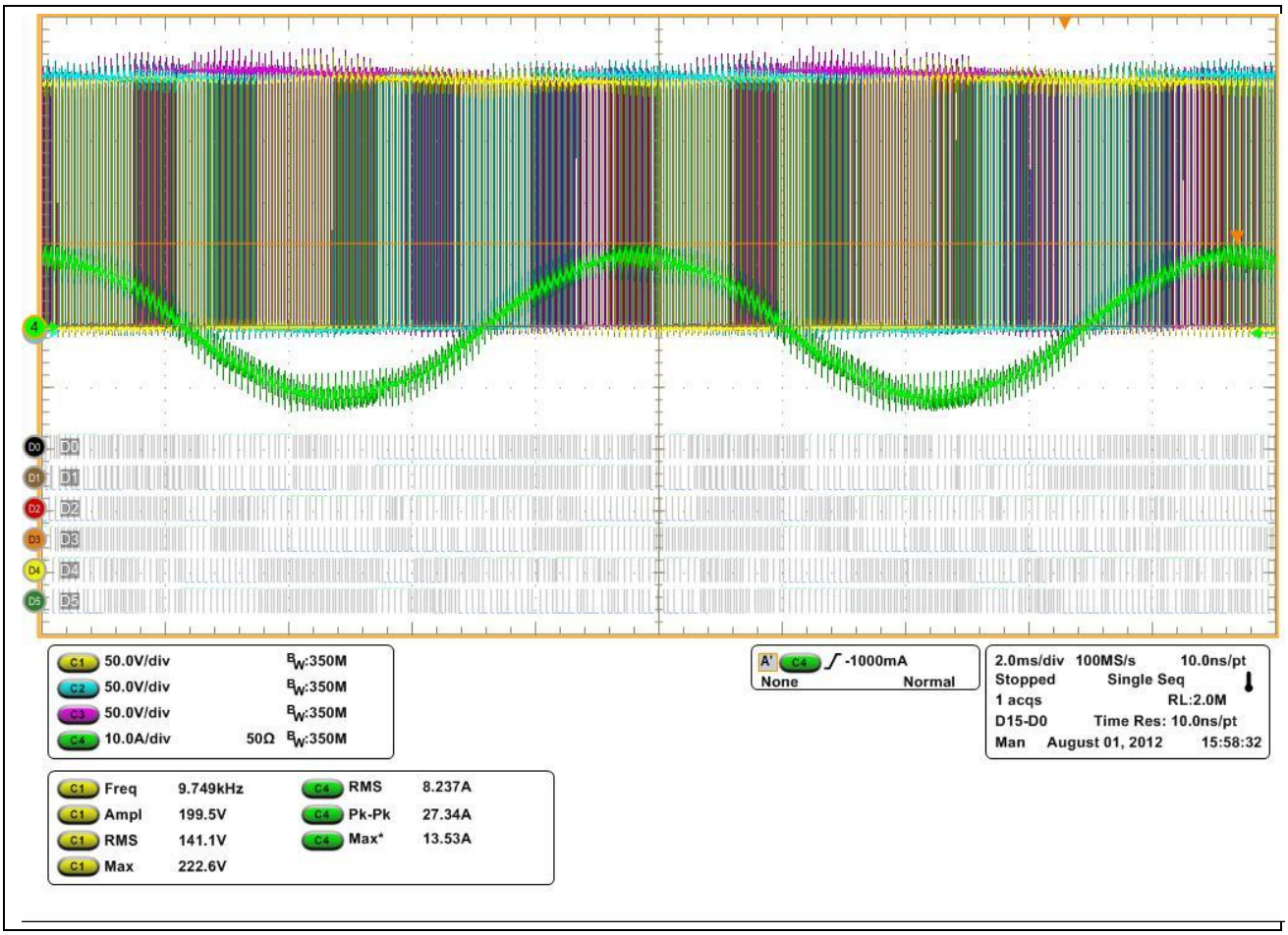
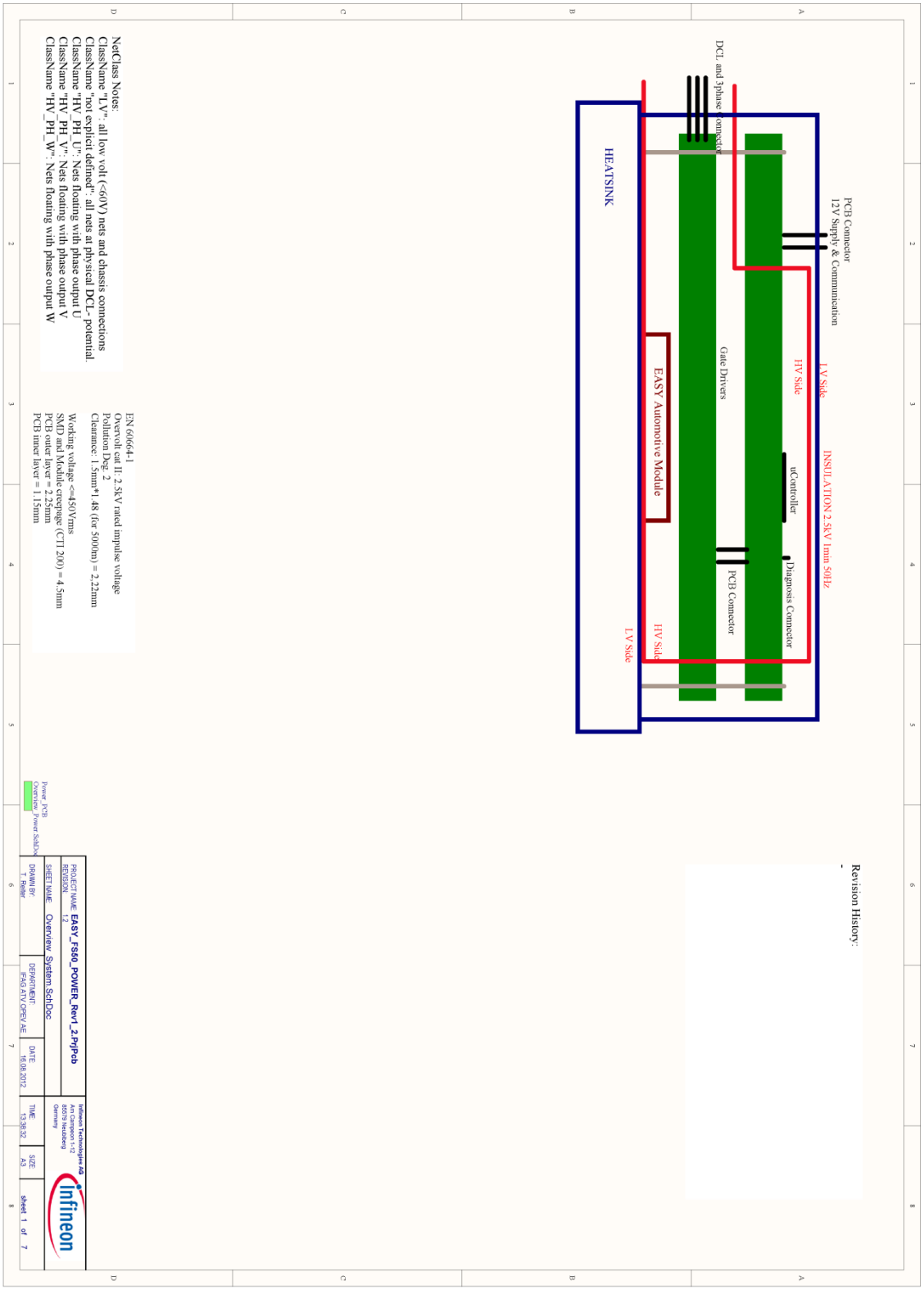


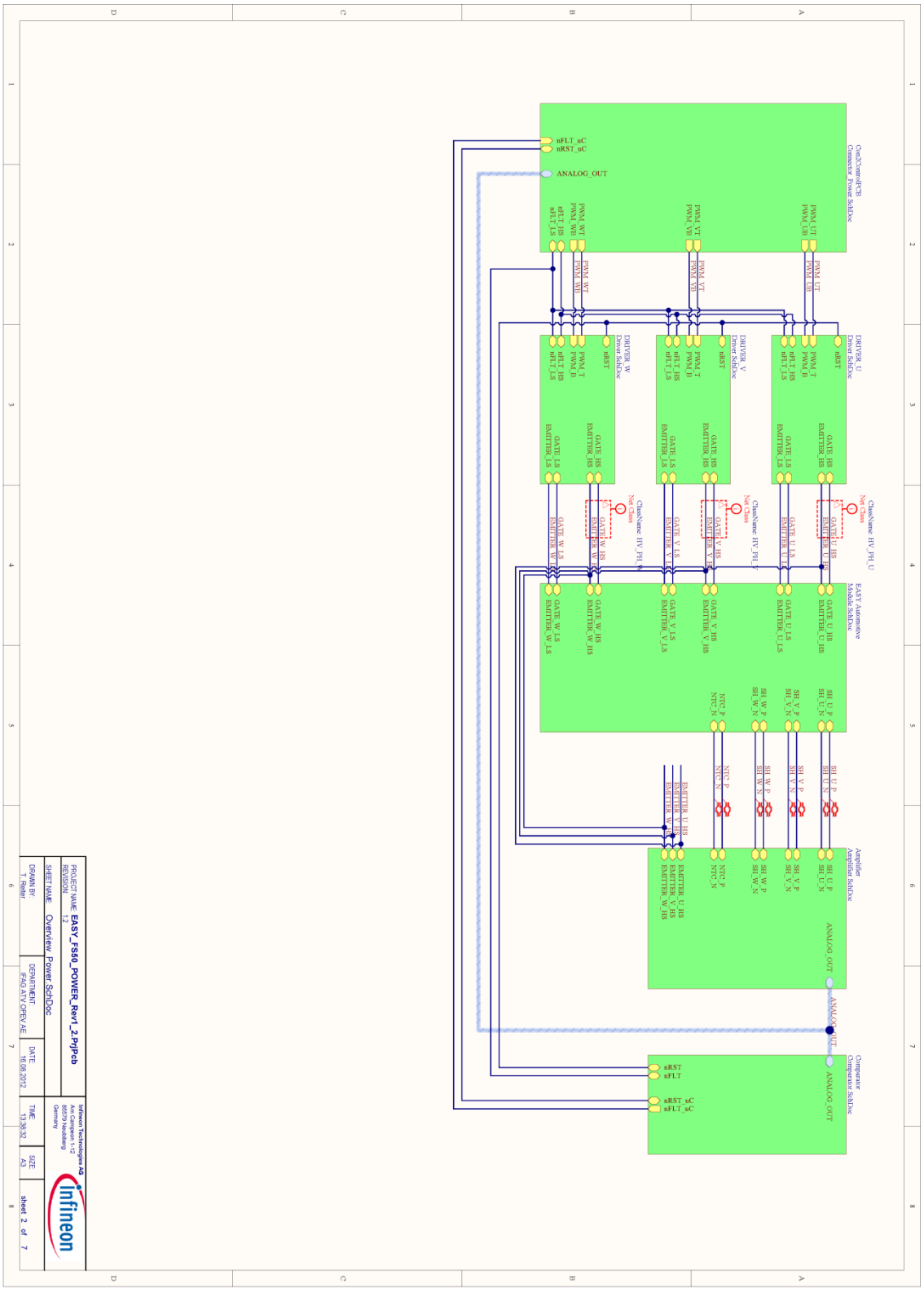
Figure 33 Evaluation Kit in motor run mode at 200V DCL voltage and 100Hz output frequency. Ch1-3 phase voltage U,V,W. Ch4 current phase U. D0: PWM_UB; D1: PWM_UT; D2: PWM_VB; D3: PWM_VT; D4: PWM_WB; D5: PWM_WT.

7 Schematics Power Board

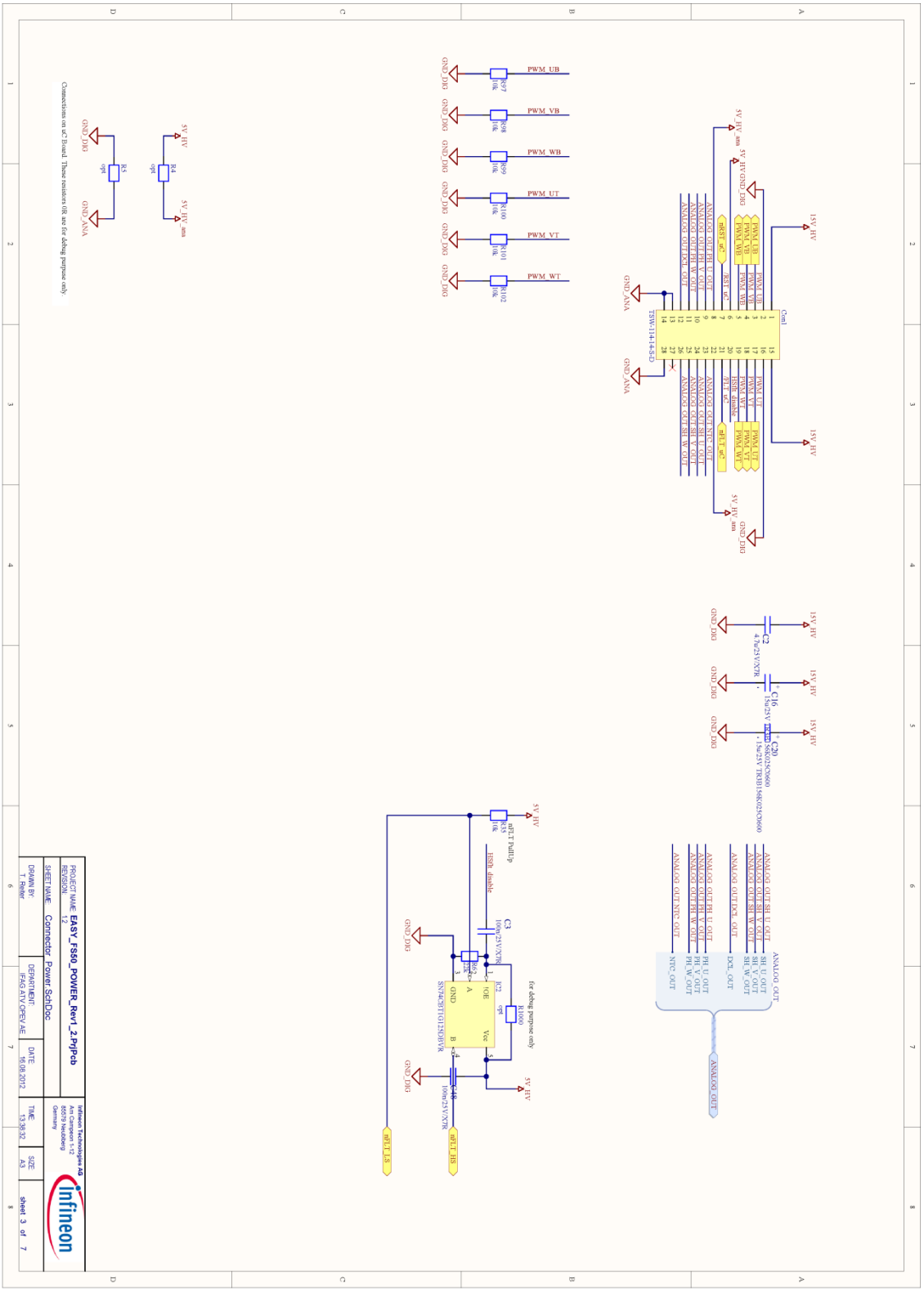
7.1 Overview Inverter System



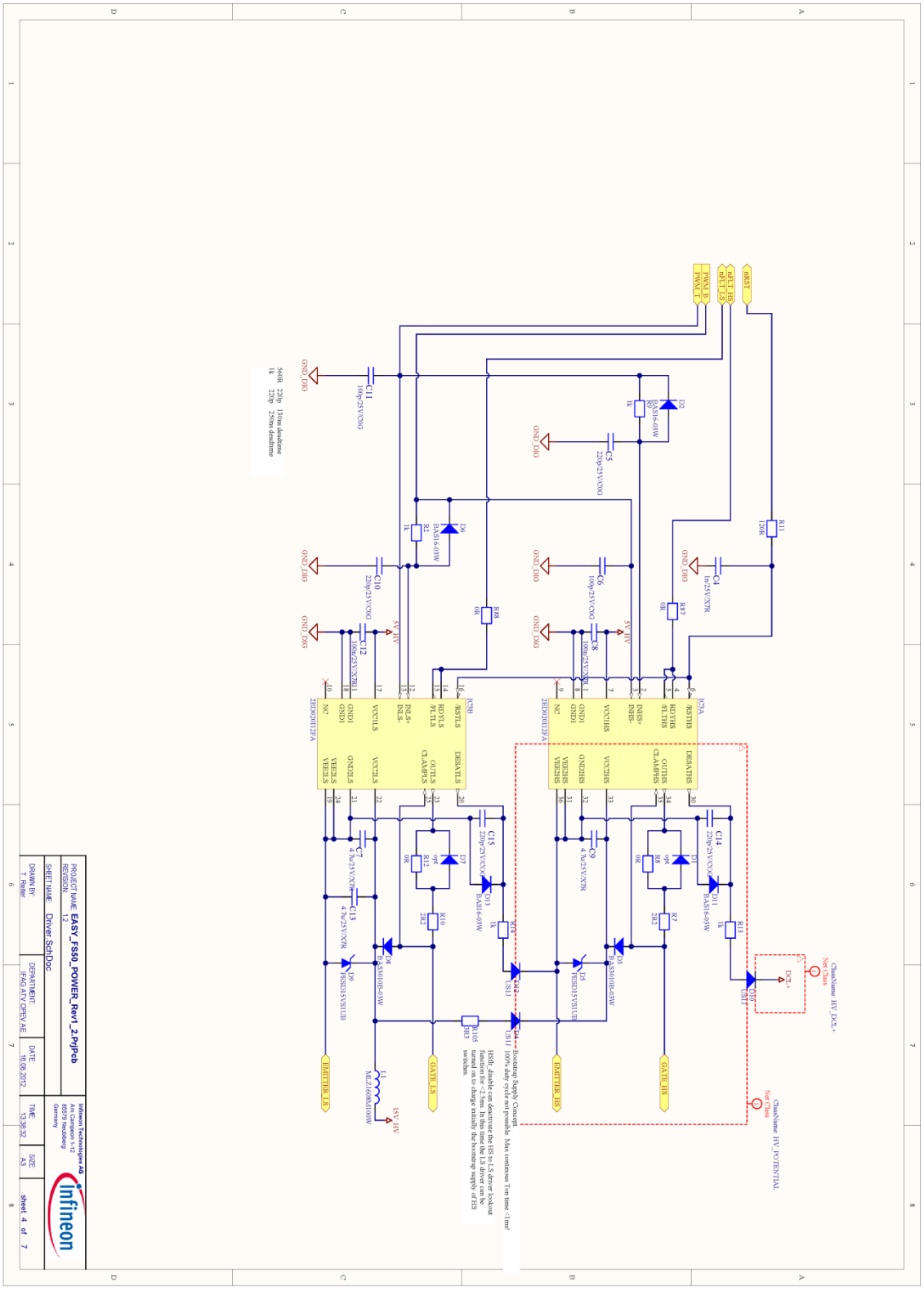
7.2 Overview Power Board



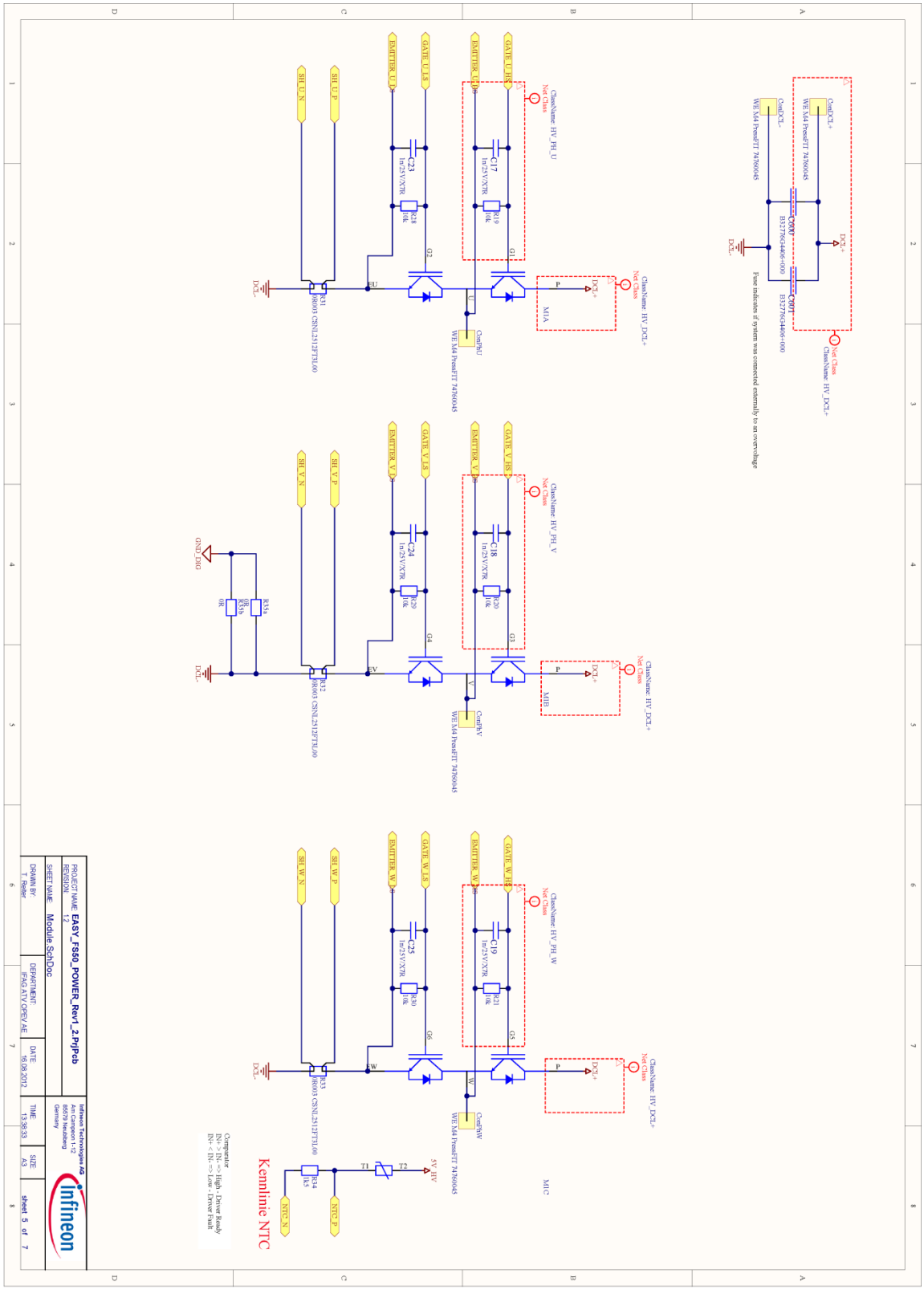
7.3 Connector on Power Board



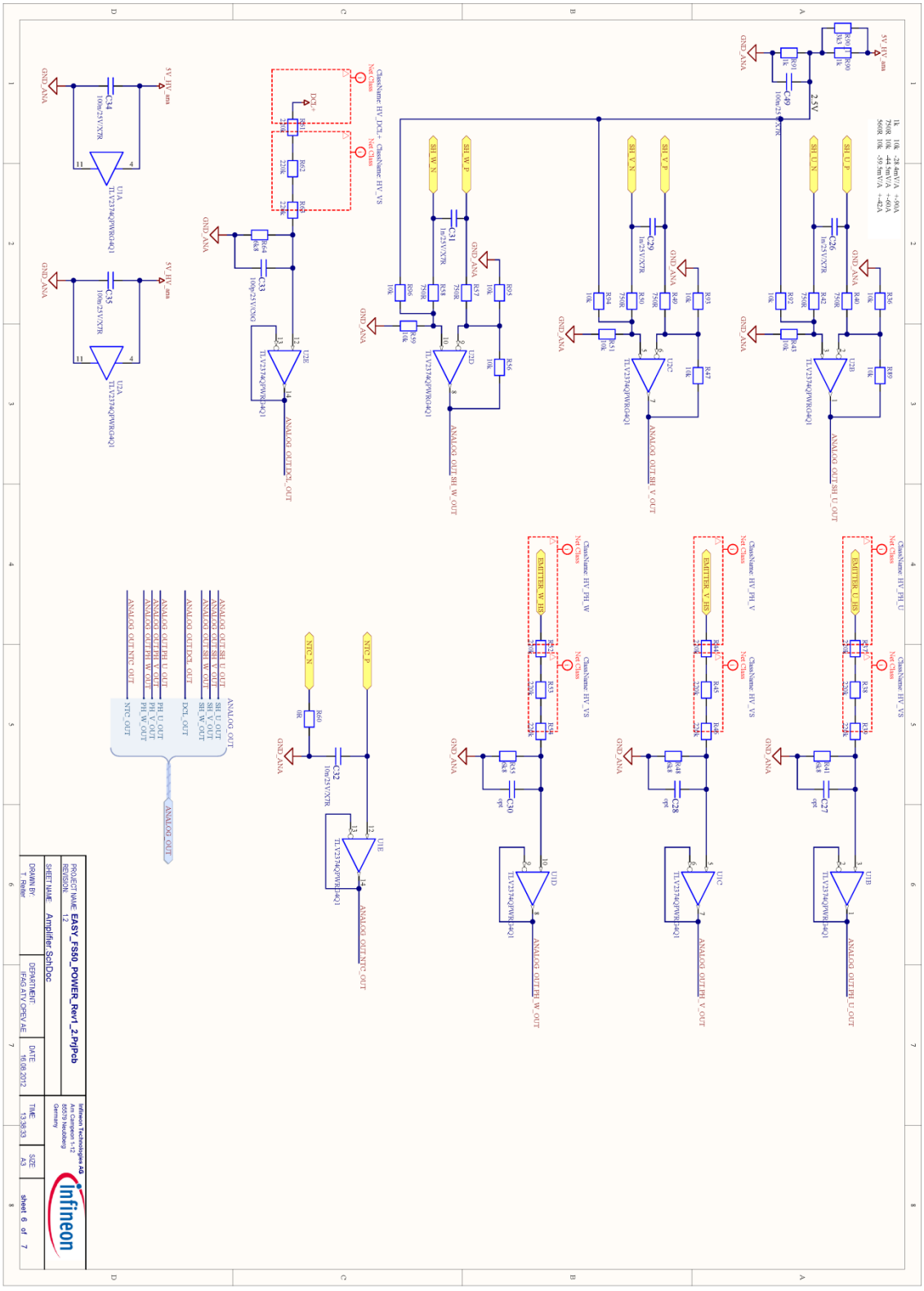
7.4 Gate Driver



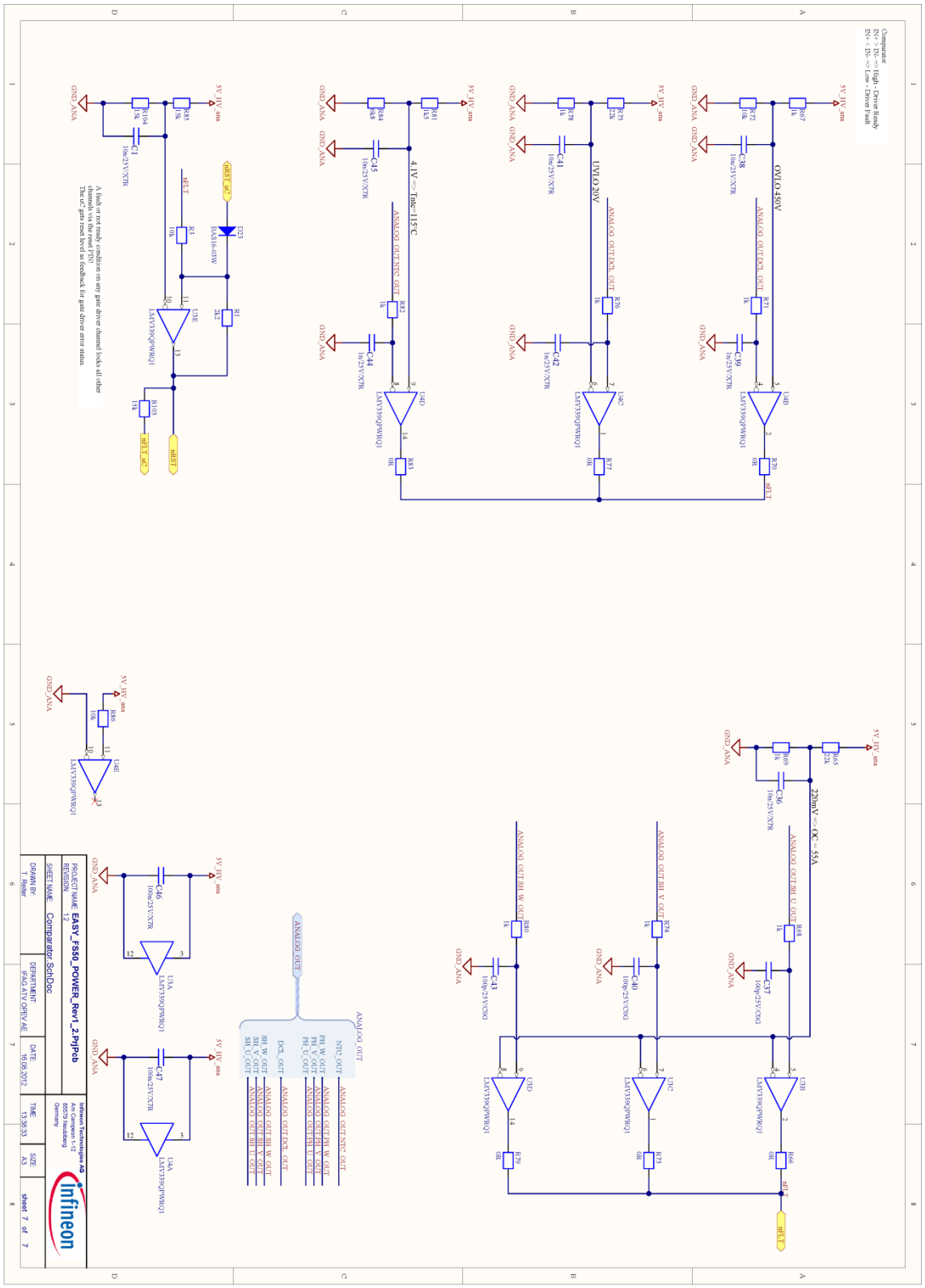
7.5 Easy Module



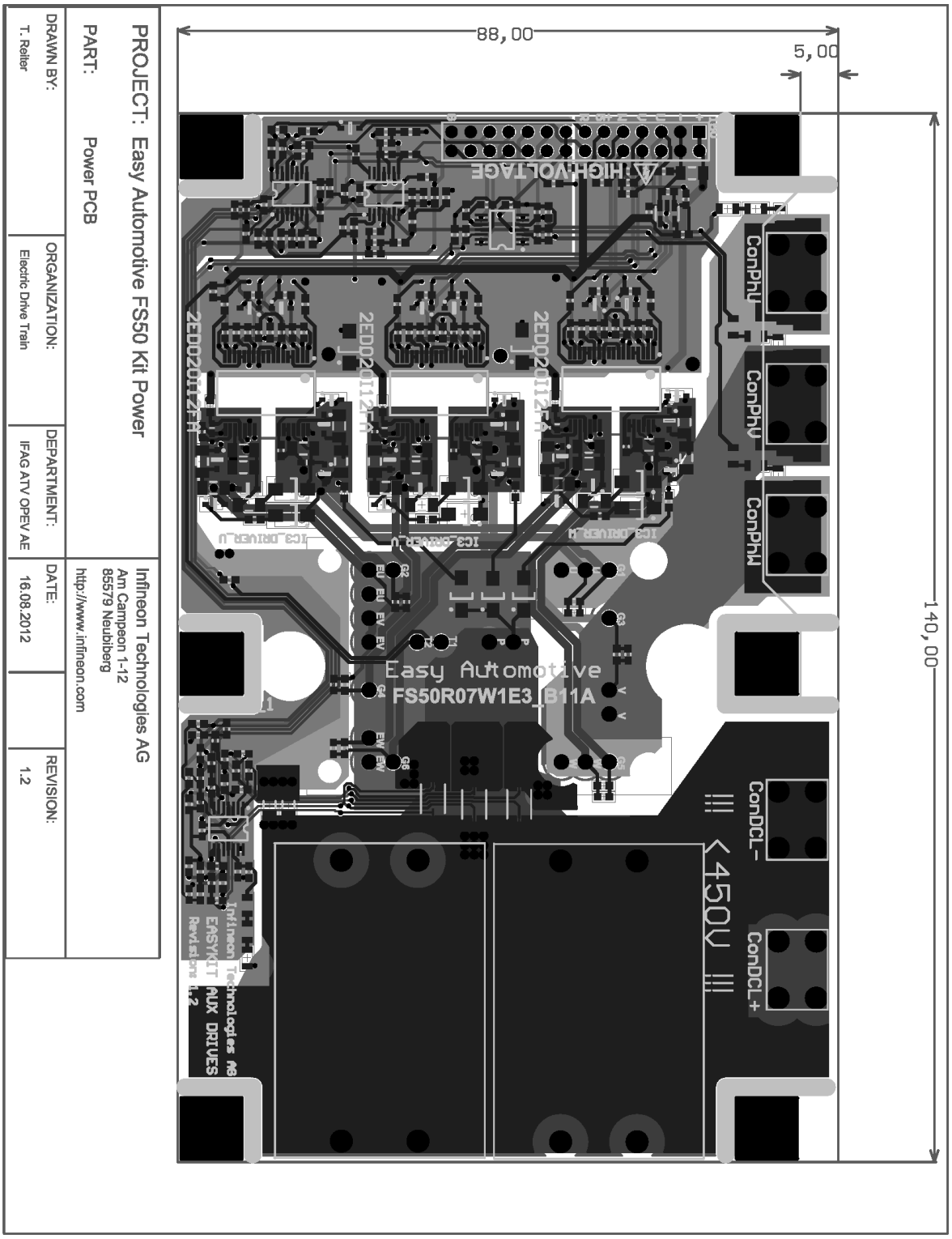
7.6 Amplifier Stage



7.7 Comparator Stage

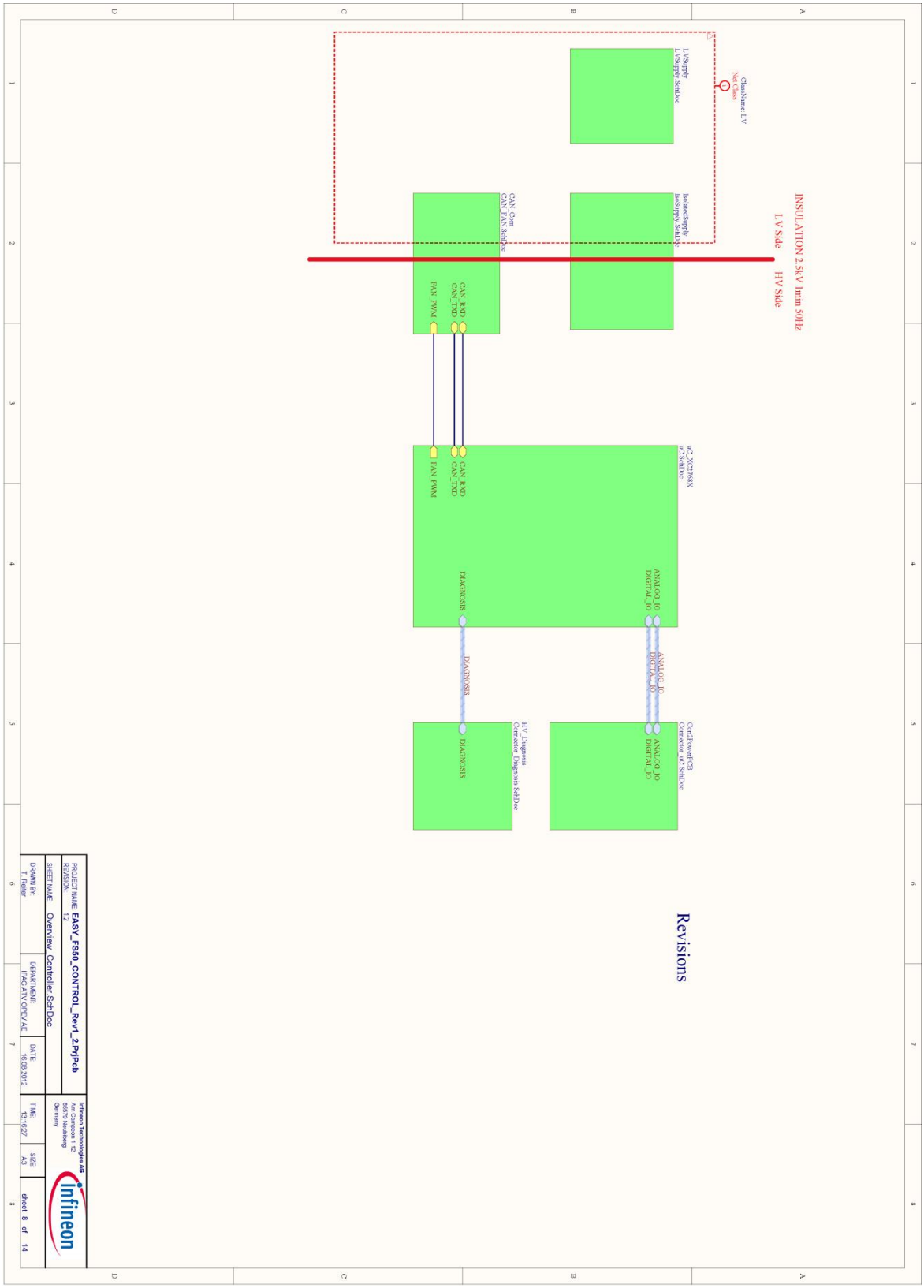


7.8 Layout and Assembly Power Board

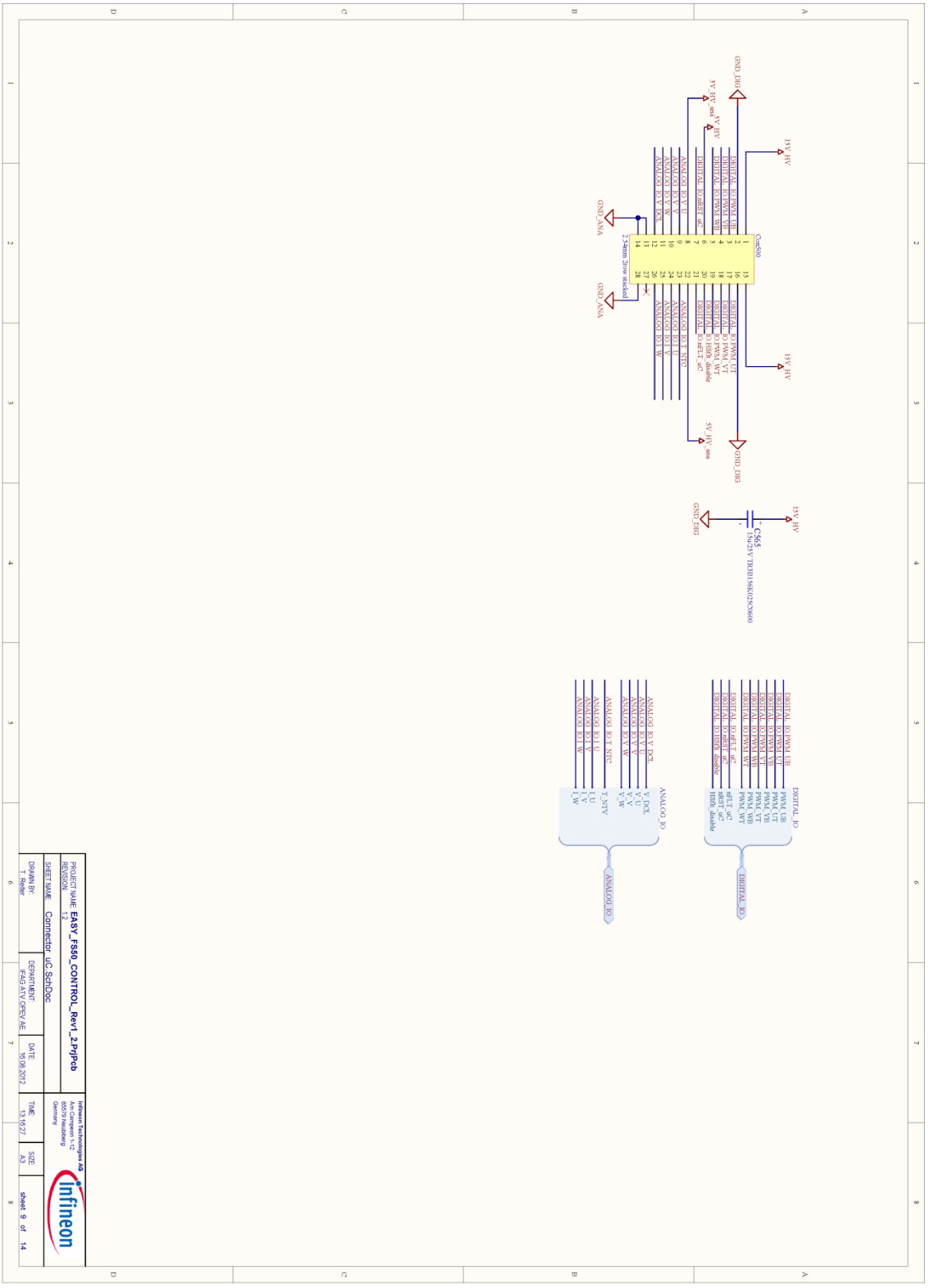


8 Schematics Control Board

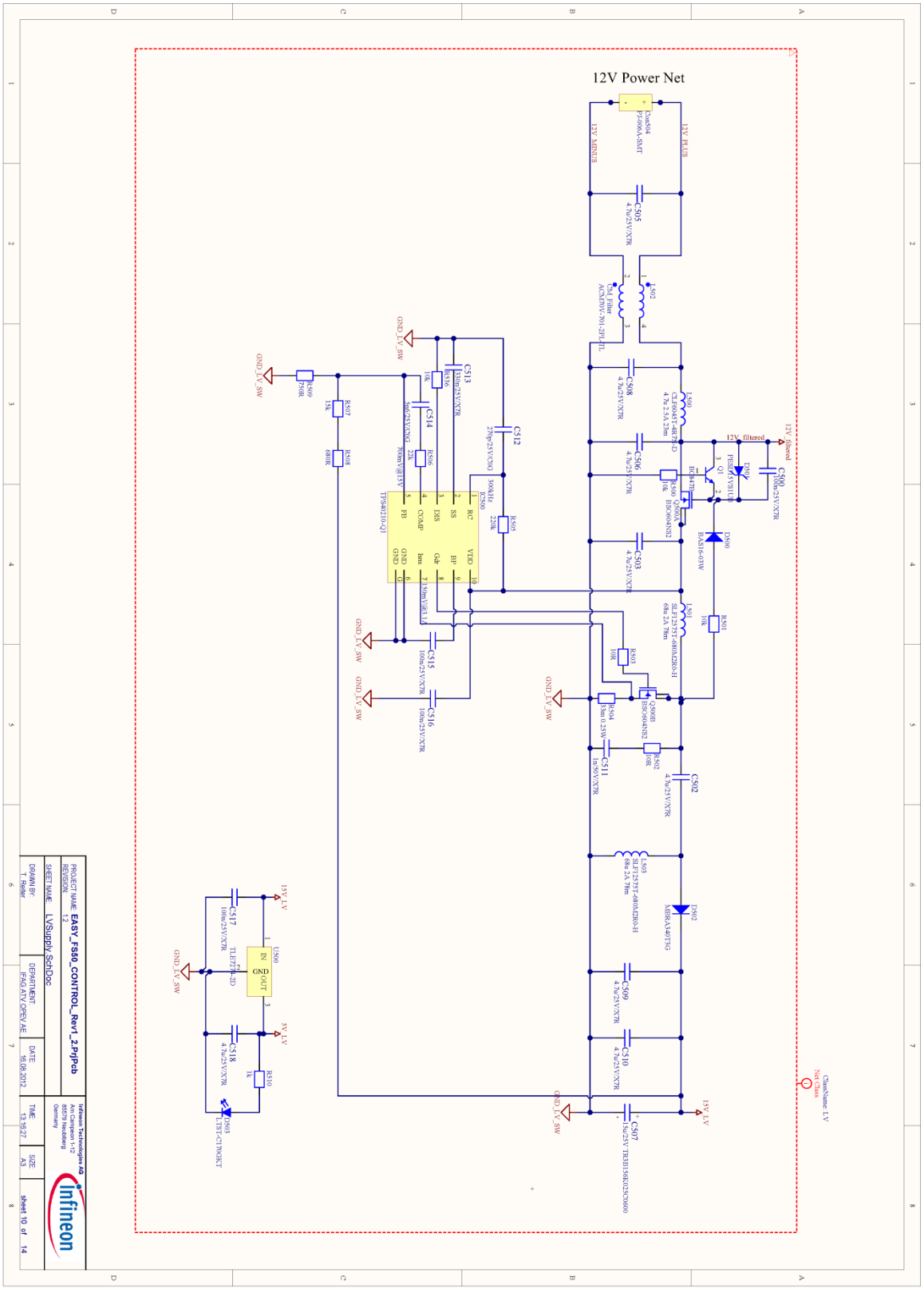
8.1 Overview Control Board



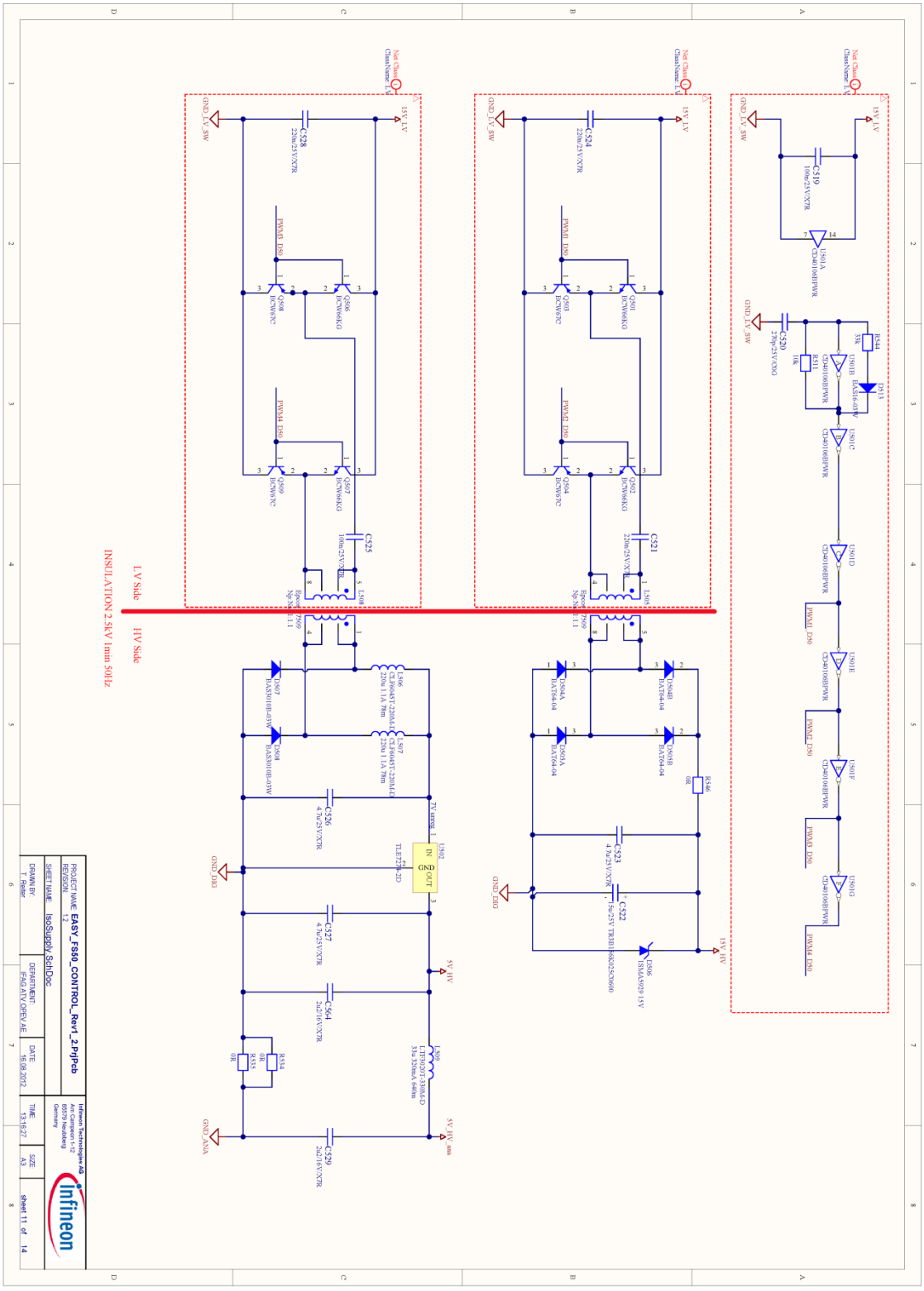
8.2 Connector from Power Board



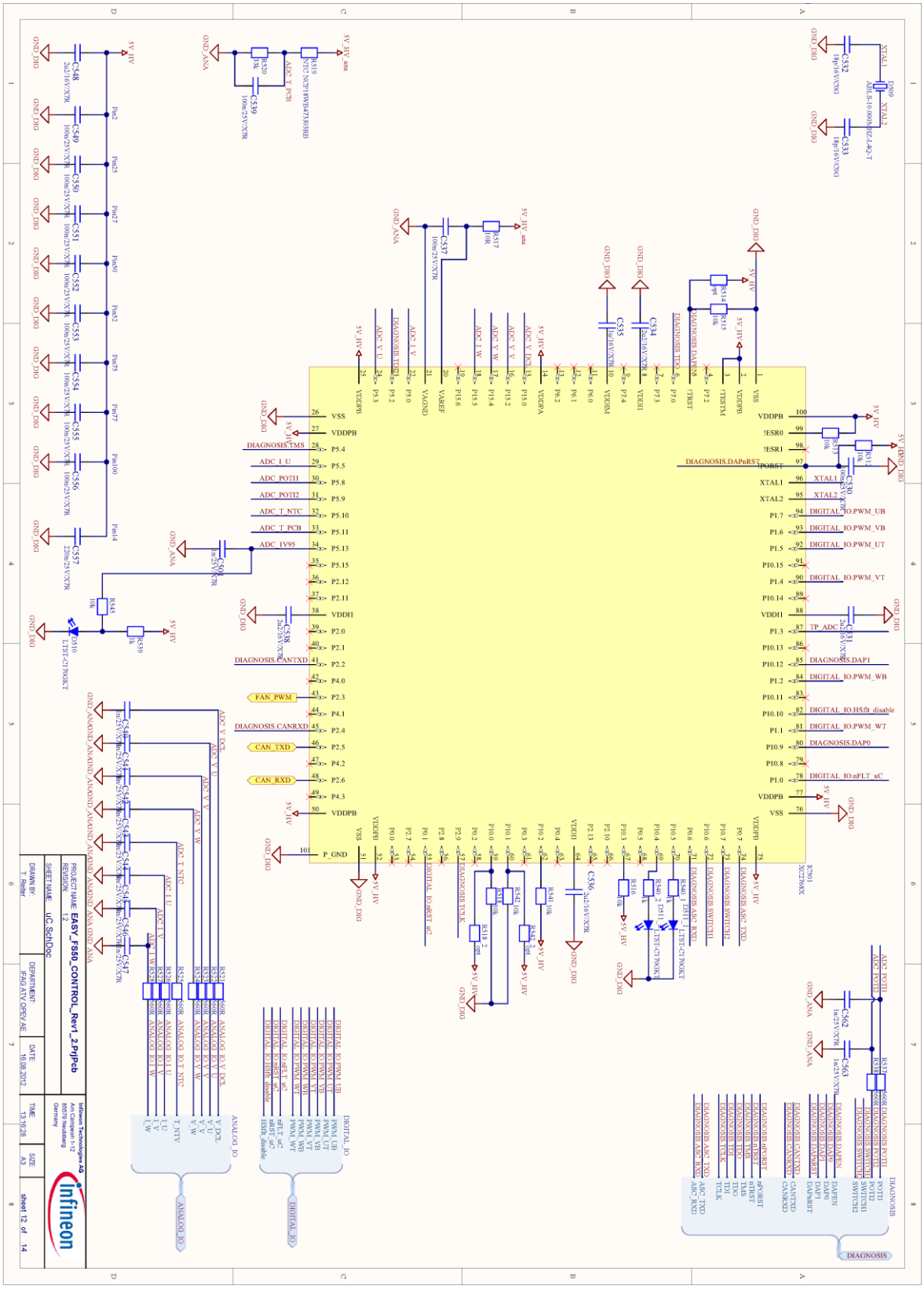
8.3 LV Supply


12V Power Net
12V_FLAIR
12V_filtered
15V_LV
5V_LV
GND_LV_SW
LVSupply.SchDoc
EASY_FS50_CONTROL_Rev1_2.PrjPcb

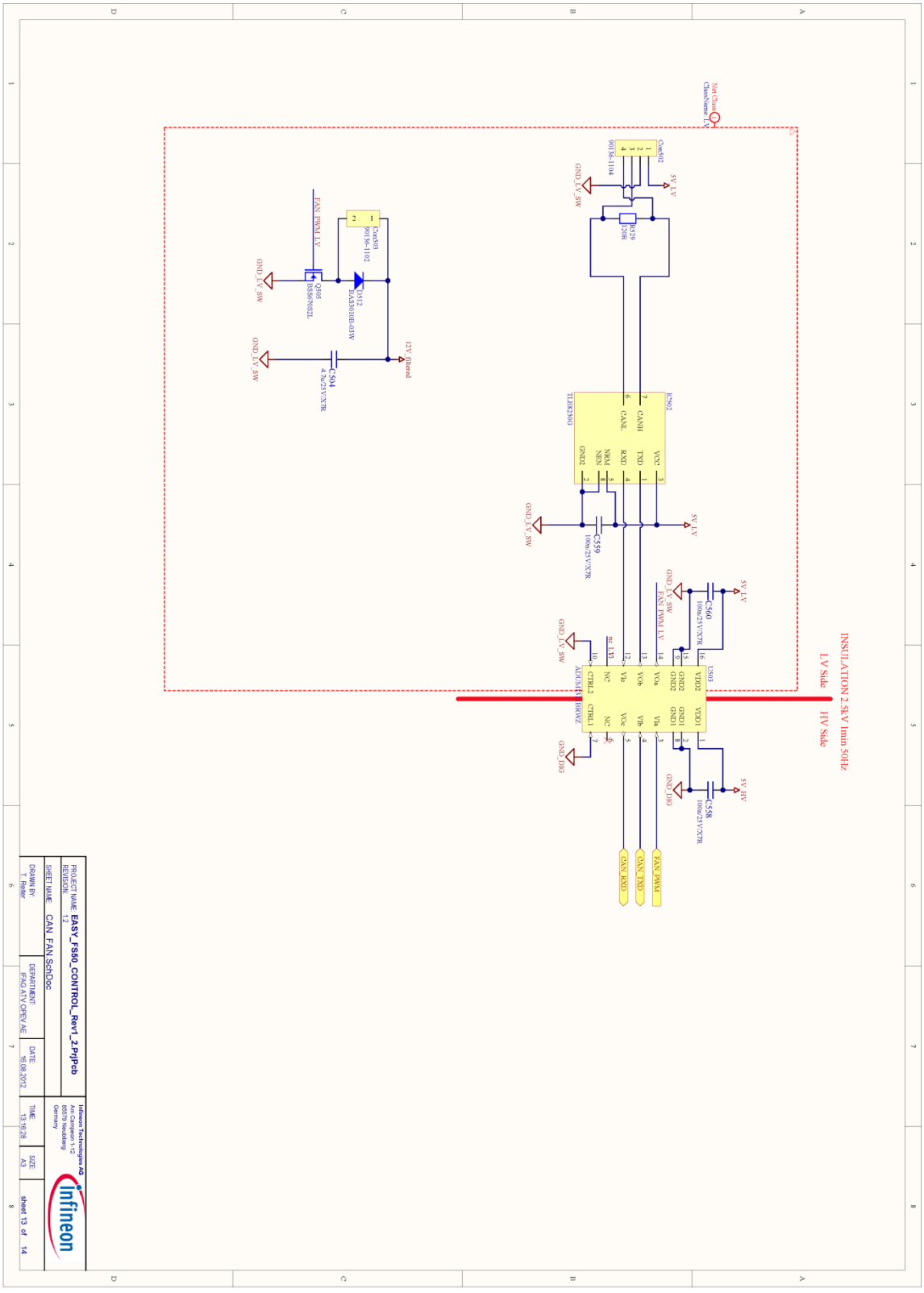
8.4 Isolated Supplies



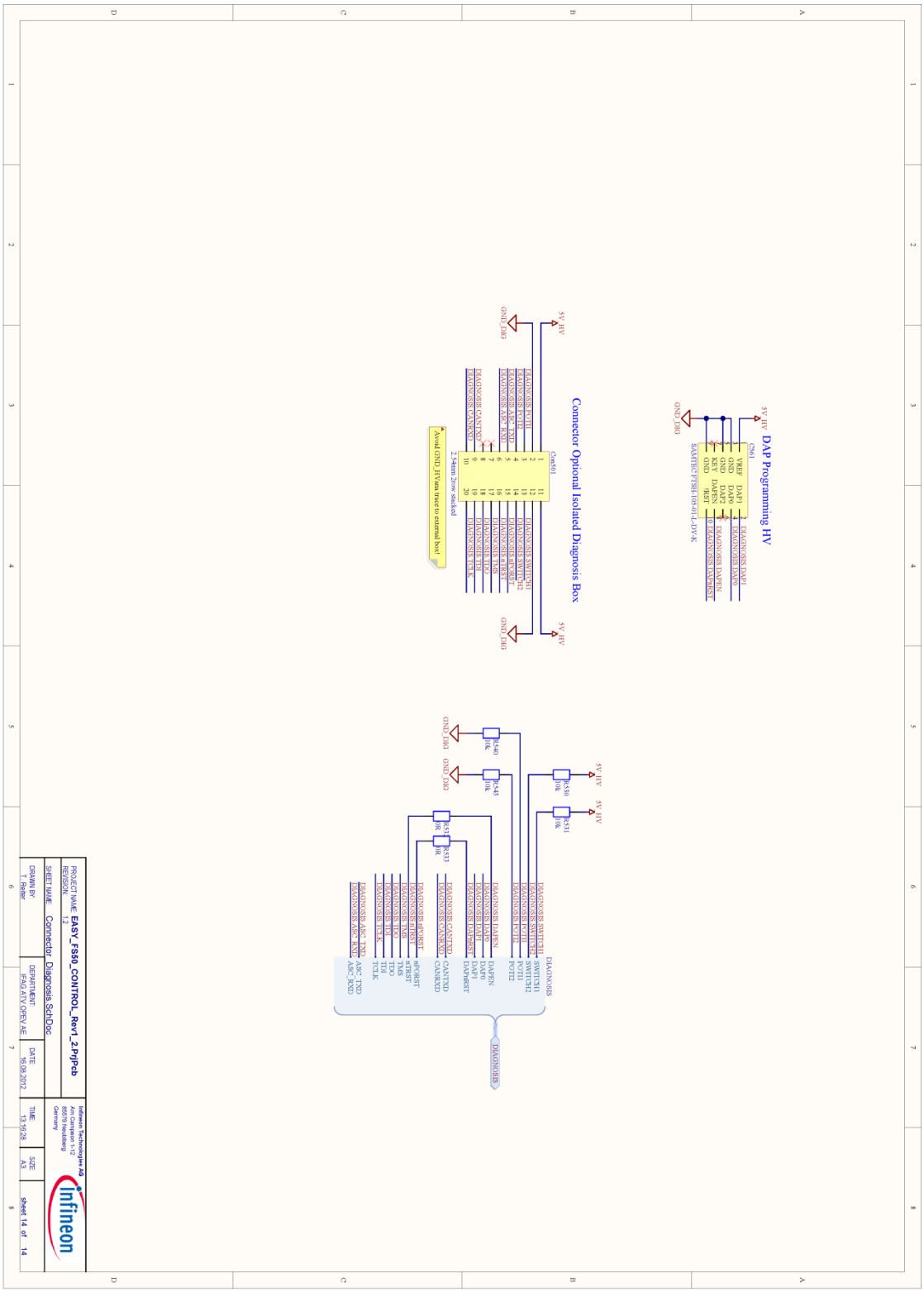
8.5 uC



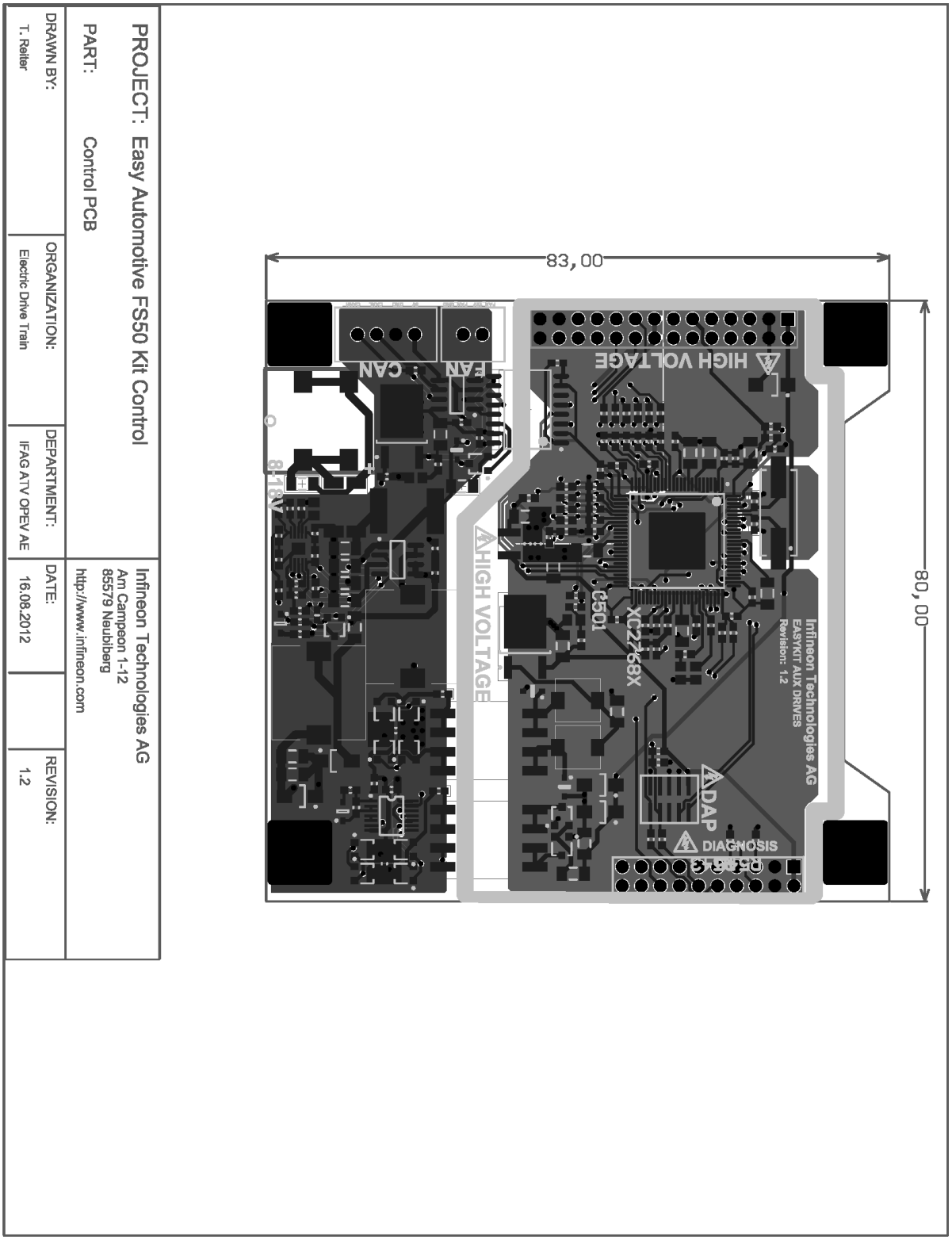
8.6 CAN Communication and FAN



8.7 Diagnosis and DAP Connector



8.8 Layout and Assembly of Control Board



9 CAN Messages

Direction	Msg.-name, ID, DLC	Update cycle	Bit - offset | length	Signal name	Categorie	Format	Unit	Possible range refer to unit [Min|Max]	Description	Reaction
Can2 FsEasyKit	De-mand, 010h, 8	read cycle 1 ms	0|1	DEnable	command	bit		[0|1]	DC/AC enable	if active → run starts in Mode 2 OR on positive edge → single pulse activation in Mode 3
			1|1	DSelftest					selftest demand with possibility to reset ERROR state	on positive edge → control state machine processes selftest
			2|1	DSglPulse					single pulse mode	if active → Mode 3
			3|1	DSglPulseULs					low side switch phase U selection	if active → single pulse will activate phase U low side switch
			4|1	DSglPulseVLs					low side switch phase V selection	if active → single pulse will activate phase V low side switch
			5|1	DSglPulseWLs					low side switch phase W selection	if active → single pulse will activate phase W low side switch
			6|9	not used						
			16|16	DSglPulseLength	analog set value	unsigned short	µs Q0	[0|65535]	single pulse duration	target value for single pulse length in Mode 3
			32|16	DFacSet		signed short	Hz Q6	[-512|511.98]	AC output frequency	target value in Mode 2
			48|16	not used						
	Param, 011h, 8	read cycle 1 ms	0|16	PFacNom	parameter value	signed short	Hz Q6	[0|1023.98]	nominal AC output frequency	nominal value for ramp up function in Mode 2 (a target value above will not further increase the output voltage)
			16|16	PVacNom		unsigned short	V Q4	[0|4095.94]	nominal AC output voltage line to line	nominal value for ramp up function in Mode 2 (will be reached at nominal output frequency)
			32|32	not used						
	012h, 8	prepared for later enhancements								
	013h, 8	prepared for later enhancements								

Direction	Msg.-name, ID, DLC	Update cycle	Bit - offset | length	Signal name	Categorie	Format	Possible range refer to unit [Min|Max]	Description	Reaction
FsEasyKit 2Can	Fast-Binary, 020h, 8	write cycle 1 ms	0|1	SelfTest	state (control state machine)	bit	[0|1]	self test is active	self test in progress
			1|1	SglPulse				single pulse mode is active (Mode 3)	single pulses on low side switches according CAN commands
			2|1	Ready				all things okay and waiting for enable (in Mode 2)	low side switches on
			3|1	Run				PWM output active	PWM output active
			4|1	Stop				DCL voltage out of operating range OR internal failure	low side switches on
			5|1	Error				repetitive internal failures	all switches off
			8|1	Enabled	general			Mode 1: every time active Mode 2 and 3: feedback of CAN command	precondition for active PWM output
			9|1	Switch1				Switch1 µC input line is on high level	if active → Mode 1 if passive → Mode 2 or 3
			10|1	Switch2				Switch2 µC input line is on high level	not used
			11|1	CanInputActive				values received from CAN will be considered	Mode 2 or Mode 3 active
			12|4	not used					
			16|1	STestFailed	error event	bit	[0|1]	self test repetitive failed	Error state
			17|1	VDclRepet				repetitive VDclHigh event	
			18|1	IUVWHighRepet				repetitive IxHigh event	
			19|1	HwFltRepet				repetitive HwFault event	
			20|1	VauxRepet				repetitive Vaux event	
			21|11	not used					
			32|1	TNtcMax	stop event	bit	[0|1]	T_NTC > 110 °C	Stop state
			33|1	TPcbMax				T_PCB > 100 °C	
			34|1	VDclHigh				V_DCL > 420 V	
			35|1	VDclLow				V_DCL < 25 V	
			36|1	IUHigh				I_U_IGBT > 54 A	
			37|1	IVHigh				I_V_IGBT > 54 A	
			38|1	IWHigh				I_W_IGBT > 54 A	
			39|1	HwFault				HW trip from supply voltage or overcurrent or overvoltage or overtemperature	
			40|1	Vaux				Ref_1V95 < 1.8 V or Ref_1V95 > 2.1 V	
			41|23	not used					

Direction	Msg.-name, ID, DLC	Update cycle	Bit - offset | length	Signal name	Categorie	Format	Possible range refer to unit [Min|Max]	Description	Reaction
FsEasyKit 2Can	Slow-Binary, 021h, 8	write cycle 100 ms	0|1	VRef	self test passive	bit	[0|1]	Ref_1V95 < 1.85 V or Ref_1V95 > 2.05 V	normal operation is locked
			1|1	TPcb				T_PCB > 105 °C	
			2|1	TNtc				T_NTC > 120 °C	
			3|1	IU				I_x mean value > 5 % measurement range	
			4|1	IV					
			5|1	IW					
			6|1	VDclMax				V_DCL > 420 V	
			7|1	VDclMin				V_DCL < 25 V	wait for DCL voltage
			8|1	ProgFlt				wait count overflow due to not responding ADC routine	normal operation is locked
			9|1	WdReset				last reset due to watchdog	only CAN information
			10|6	not used					
			16|1	ULsFlt	self test active low side	bit	[0|1]	HW trip due to phase U low side switch test pulse	normal operation is locked
			17|1	ULsVce				VU_IGBT > 7 V during phase U low side switch test pulse	
			18|1	ULsI				IU_IGBT < -5 A or IU_IGBT > 5 A during phase U low side switch test pulse	
			19|1	ULsVDcl				delta V_DCL before pulse and V_DCL during phase U low side pulse > 10 V	
			20|1	VLsFlt				HW trip due to phase V low side switch test pulse	
			21|1	VLsVce				VV_IGBT > 7 V during phase V low side switch test pulse	
			22|1	VLsI				IV_IGBT < -5 A or IV_IGBT > + 5 A during phase V low side switch test pulse	
			23|1	VLsVDcl				delta V_DCL before pulse and V_DCL during phase V low side pulse > 10 V	
			24|1	WLsFlt				HW trip due to phase W low side switch test pulse	
			25|1	WLsVce				VW_IGBT > 7 V during phase W low side switch test pulse	
			26|1	WLsI				IW_IGBT < -5 A or IW_IGBT > 5 A during phase W low side switch test pulse	
			27|1	WLsVDcl				delta V_DCL before pulse and V_DCL during phase W low side pulse > 10 V	
			28|1	LsProgFlt				wait count overflow due to not responding PWM or ADC routine	
			29|3	not used					
			32|1	UHsFlt	self test active high side	bit	[0|1]	HW trip due to phase U low and high side switch test pulse pattern	normal operation is locked
			33|1	UHsVce				(V_DCL - VU_IGBT) > (7 V + 5% of V_DCL) during phase U high side switch pulse	
			34|1	UHsI				IU_IGBT < -5 A or IU_IGBT > 5 A during phase U high side switch test pulse	
			35|1	UHsVDcl				delta V_DCL before pulse pattern and V_DCL during phase U high side pulse > 10 V	
			36|1	VHsFlt				HW trip due to phase V low and high side switch test pulse pattern	
			37|1	VHsVce				(V_DCL - VV_IGBT) > (7 V + 5% of V_DCL) during phase V high side switch pulse	
			38|1	VHsI				IV_IGBT < -5 A or IV_IGBT > 5 A during phase V high side switch test pulse	
			39|1	VHsVDcl				delta V_DCL before pulse pattern and V_DCL during phase V high side pulse > 10 V	
			40|1	WHsFlt				HW trip due to phase V low and high side switch test pulse pattern	
			41|1	WHsVce				(V_DCL - VW_IGBT) > (7 V + 5% of V_DCL) during phase W high side switch pulse	
			42|1	WHsI				IW_IGBT < -5 A or IW_IGBT > 5 A during phase W high side switch test pulse	
			43|1	WHsVDcl				delta V_DCL before pulse pattern and V_DCL during phase W high side pulse > 10	
			44|1	HsProgFlt				wait count overflow due to not responding PWM or ADC routine	

Direction	Msg.-name, ID, DLC	Update cycle	Bit - offset | length	Signal name	Categorie	Format	Unit	Possible range refer to unit [Min|Max]	Expected range	Description
FsEasyKit 2Can	**De-bug1**, 022h, 8	write cycle 0.2 ms	0|16	IU_IGBT_	analog measured value	signed short	A Q6	[-512| 511.98]	-62 A - 62 A	low side phase U current - during LowSide IGBT on
			16|16	IV_IGBT_						low side phase V current - during LowSide IGBT on
			32|16	IW_IGBT_						low side phase W current - during LowSide IGBT on
			48|16	V_DCL_		unsigned short	V Q4	[0| 4095.94]	0 V - 490 V	DCL-voltage
	023h, 8	prepared for later enhancements								
	Fast-Analog1, 024h, 8	write cycle 10 ms	0|16	V_DCL	analog measured value	unsigned short	V Q4	[0| 4095.94]	0 V - 490 V	DCL-voltage
			16|16	MIdx	program generated value		%	[0|200]	0 % - 94 %	PWM modulation index
			32|16	VacCalc			V Q4	[0| 4095.94]	0 V - 270 V	AC output voltage line to line RMS calculated
			48|16	FacAct		signed short	Hz Q6	[-512| 511.98]	-512 Hz - 511.98 Hz	actual AC output frequency
	Fast-Analog2, 025h, 8	write cycle 10 ms	0|16	IU_IGBT	analog measured value	signed short	A Q6	[-512| 511.98]	-62 A - 62 A	low side phase U current - during LowSide IGBT on
			16|16	IU_Diode						- during LowSide IGBT off
			32|16	VU_IGBT		unsigned short	V Q4	[0| 4095.94]	0 V - 490 V	phase U voltage - during LowSide IGBT on
			48|16	VU_Diode						- during LowSide IGBT off
	Fast-Analog3, 026h, 8	write cycle 10 ms	0|16	IV_IGBT	analog measured value	signed short	A Q6	[-512| 511.98]	-62 A - 62 A	low side phase V current - during LowSide IGBT on
			16|16	IV_Diode						- during LowSide IGBT off
			32|16	VV_IGBT		unsigned short	V Q4	[0| 4095.94]	0 V - 490 V	phase V voltage - during LowSide IGBT on
			48|16	VV_Diode						- during LowSide IGBT off
	Fast-Analog4, 027h, 8	write cycle 10 ms	0|16	IW_IGBT	analog measured value	signed short	A Q6	[-512| 511.98]	-62 A - 62 A	low side phase W current - during LowSide IGBT on
			16|16	IW_Diode						- during LowSide IGBT off
			32|16	VW_IGBT		unsigned short	V Q4	[0| 4095.94]	0 V - 490 V	phase W voltage - during LowSide IGBT on
			48|16	VW_Diode						- during LowSide IGBT off
	Slow-Analog1, 028h, 8	write cycle 100 ms	0|16	FacNomSet_ POTI1	analog measured value / program generated value	signed short	Hz Q6	[-512| 511.98]	-500 Hz - 500 Hz	AC output frequency set if Poti signal detected → scaled Poti signal; else → nominal value (SW defined)
			16|16	VacNom_ POTI2		unsigned short	V Q4	[0| 4095.94]	0 V - 300 V	AC output voltage line to line RMS set if Poti signal detected → scaled Poti signal; else → nominal value (SW defined)
			32|16	T_NTC	analog measured	signed short	°C Q4	[-2048| 2047.94]	-40 °C - 200 °C	NTC temperature
			48|16	T_PCB						PCB temperature
	Slow-Analog2, 029h, 8	write cycle 100 ms	0|16	REF_1V95	analog measured	unsigned short	V Q12	[0|16]	0 V - 5 V	auxiliary supply reference voltage
			16|16	F_AC_SET	program generated values	signed short	Hz Q6	[-512| 511.98]	-512 Hz - 511.98 Hz	active AC output frequency set value
			32|16	F_AC_NOM		unsigned short		[0| 1023.98]	1 Hz - 512 Hz	active nominal AC output frequency value
			48|16	V_AC_NOM			V Q4	[0| 4095.94]	10 V - 270 V	active nominal AC output line to line RMS value
	Slow-Analog3, 02Ah, 8	write cycle 100 ms	0|8	PrgBld_Year	program building time stamp	unsigned char		[0|255]	0 - 99	year without century
			8|8	PrgBld_Month					1 - 12	month
			16|8	PrgBld_Day					1 - 31	date
			24|8	PrgBld_Hour			h		0 - 23	hour
			32|8	PrgBld_Minute			min		0 - 59	minute
			40|8	PrgBld_Second			sec		0 - 59	second
			48|16	not used						

10 References

The referenced application notes can be found at http://www.infineon.com
Direct link to the Easy Automotive site:
http://www.infineon.com/autoeasy

[1] Infineon Application Note AN2010-09, “Explanation of Technical Information”.
[2] Infineon Application Note AN2009-01, “Easy PressFIT Assembly Instructions”.
[3] Infineon Application Note AN2011-11, “Explanation for Traceability of the Easy Automotive Modules”.

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